LUND UNIVERSITY

Time-space Appropriation in the Inka Empire

A Study of Imperial Metabolism

BOGADÓTTIR, RAGNHEIDUR

2016

Document Version:
Publisher's PDF, also known as Version of record

Link to publication

Citation for published version (APA):
BOGADÓTTIR, RAGNHEIDUR. (2016). *Time-space Appropriation in the Inka Empire: A Study of Imperial Metabolism*. [Doctoral Thesis (monograph), Human Ecology]. Lund University.

Total number of authors:
1

General rights
Unless other specific re-use rights are stated the following general rights apply:
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.
• Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
• You may not further distribute the material or use it for any profit-making activity or commercial gain
• You may freely distribute the URL identifying the publication in the public portal

Read more about Creative commons licenses: https://creativecommons.org/licenses/

Take down policy
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

LUND UNIVERSITY

PO Box 117
221 00 Lund
+46 46-222 00 00

Download date: 04. Jun. 2026

LUND STUDIES IN HUMAN ECOLOGY 15

Time-space Appropriation in the Inka Empire

A Study of Imperial Metabolism

Ragnheiður Bogadóttir

LUND
UNIVERSITY

Time-space Appropriation in the Inka Empire

Time-space Appropriation in the Inka Empire

A Study of Imperial Metabolism

Ragnheiður Bogadóttir

DOCTORAL DISSERTATION
by due permission of the Faculty of Social Sciences, Lund University, Sweden.
To be defended at Flygeln, Geocentrum I, Sölvegatan 10, Lund, Friday 16th of September 2016 at 10.00

Faculty opponent
Professor Cathy L. Costin

<table>
<tr><td colspan="2">Organization
LUND UNIVERSITY
Department of Human Geography and the Human Ecology Division
Sölvegatan 10,
223 62 Lund</td><td colspan="2">Document name
DOCTORAL DISSERTATION</td></tr>
<tr><td colspan="2"></td><td colspan="2">Date of issue
September 2016</td></tr>
<tr><td colspan="2">Author(s)
Ragnheiður Bogadóttir</td><td colspan="2">Sponsoring organization
FORMAS The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning</td></tr>
<tr><td colspan="4">Title and subtitle
Time-space Appropriation in the Inka Empire: A Study of Imperial Metabolsim.</td></tr>
<tr><td colspan="4">Abstract
This thesis analyzes some aspects of the appropriation of labor time and natural space in the Inka Empire (ca. AD 1400 – 1532) in order to illuminate the cultural organization of Inka imperial metabolism. Rather than understanding Inka imperialism simply as a political process with socioecological consequences, it is investigated as an ecological process organized through specific cultural categories. The Inka imperial economy is conceptualized in terms of transfers of time and space between different categories of people.
The thesis thus addresses long-standing questions regarding the economic operation of the Inka Empire as well as central issues in general social theory. It demonstrates how imperial power is based on biophysical flows of embodied labor and land, organized by specific cultural permutations of reciprocity and redistribution. The thesis focuses on estimating these flows through analyses of time-space appropriation. This is done by reconstructing, on the basis of archaeological, historical and ethnographic data, the production processes of three emblematic Inka artifacts: textiles, chicha (maize beer), and stone walls.</td></tr>
<tr><td colspan="4">Key words: Inka Empire, time-space appropriation, ecologically unequal exchange, historical political ecology, human ecology</td></tr>
<tr><td colspan="4">Classification system and/or index terms (if any)</td></tr>
<tr><td colspan="3">Supplementary bibliographical information</td><td>Language: English</td></tr>
<tr><td colspan="3">ISSN and key title
1403-5022 (Lund Studies in Human Ecology 15)</td><td>ISBN
978-91-7623-898-1</td></tr>
<tr><td>Recipient’s notes</td><td colspan="2">Number of pages 198</td><td>Price</td></tr>
<tr><td></td><td colspan="3">Security classification</td></tr>
</table>

I, the undersigned, being the copyright owner of the abstract of the above-mentioned dissertation, hereby grant to all reference sources permission to publish and disseminate the abstract of the above-mentioned dissertation.

Signature Ragnheiður Bogadóttir Date 8/8 - 2016

Time-space Appropriation in the Inka Empire

A Study of Imperial Metabolism

Ragnheiður Bogadóttir

LUND
UNIVERSITY

Copyright © Ragnheiður Bogadóttir 2016

Illustration on rear cover by Kristina Anshelm

Faculty of Social Sciences
Department of Human Geography and the Human Ecology Division

ISBN 978-91-7623-898-1
ISSN 1403-5022

Printed in Sweden by Media-Tryck, Lund University
Lund 2016

To my parents

Table of Contents

Acknowledgements 10

1. Introduction 13
   1.1 A note on orthography and the term “Inka” 17
   1.2 Overview of thesis 17

2. Theoretical framework 21
   2.1 Imperialism 23
   2.2 Social metabolism and Inka imperial metabolism 24
   2.3 Capital accumulation in noncapitalist societies 25
   2.4 Historical political ecology 26
   2.5 Economic anthropology 34
      2.5.1 Reciprocity and moral principles of exchange 35
      2.5.2 Ideologies of reciprocity and their materialization 38

3. Methods and perspectives 43
   3.1 Data and limitations 43
   3.2 Time, space and energy 46
   3.3 Time, space and inequality 47
   3.4 Time and space in the Andes - *Pacha* 49

4. Tawantinsuyu, the Inka Empire 53
   4.1 Reading the Inka landscape 56
      4.1.1 Ritual commensality 58
      4.1.2 The *zeq’e* system 61
      4.1.3 Complementarity and dual organization 62
      4.1.4 The Inka tribute and administrative system 65
      4.1.5 *Khipu* – Inka accounting technology 69
      4.1.6 The productive Andean landscape 71
      4.1.7 Andean land-use zones 75
      4.1.8 The Andean agropastoral landscape 75

4.1.9 The built landscape – Inka architecture 76

5. Case studies: textiles, *chicha,* and stone walls 81

5.1 A note on the generalization of standards for calculation 83

5.2 Textiles 86
5.2.1 Inka textiles in historical perspective 87
5.2.2 The role of textile in the Inka political economy 87
5.2.3 Who made the textiles? 96
5.2.4 Discussion of results 97

5.3 *Chicha* 99
5.3.1 *Chicha* in historical perspective 100
5.3.2 The role of *chicha* in the Inka political economy 101
5.3.3 Reciprocity, labor, and *chicha* in the Inka Empire 103
5.3.4 Inputs in *chicha* production: maize, pots, fuel, and labor 104
5.3.5 The process of *chicha* brewing 107
5.3.6 Who made the chicha? 122
5.3.7 Discussion of results 124

5.4 Stone walls 125
5.4.1 The Inka culture of stone 127
5.4.2 Inka walls 128
5.4.3 Inka stone masonry in historical perspective 131
5.4.4 Terrace retaining walls 132
5.4.5 Who made the walls? 134
5.4.6 Discussion of results 145

6. Inka imperial metabolism 149

6.1 Reconceptualizing time as space 149

6.2 Prehispanic Andean ecological footprints 150

6.3 Productive capacity of Andean land-use zones 159

7. Results and conclusions 165

7.1 Material footprints of Inka artifacts 165

7.2 Concluding remarks 168

8. References 171

Acknowledgements

So many people contributed to this work in so many different yet invaluable ways which I can never duly acknowledge in these few lines.

I would like to thank first the people who have been part of the Human Ecology Division at Lund University, students and staff alike, since I stumbled across my first undergraduate course in human ecology more than a decade ago and immediately realized here was the place and the knowledge I had been searching for. Some of you became dear friends, and some of you have no idea what impact you made on me. A deep gratitude goes to you all for creating places like this in the world. In this respect, and for continued support, guidance and encouragement throughout the process of thesis writing, special thanks must go to my supervisor and Head of Division Professor Alf Hornborg. Likewise to Professors Thomas Malm and Pernille Gooch who were there from the beginning, and to Professor Susan Paulson who was there for a while and made a very big impression. *Abrazos amiga*. A very large group of colleagues and fellow PhD students in both human ecology and other fields provided a vibrant and stimulating environment; Anders Burman, Richard Langlais, Love Eriksen, Sabina Andrén, Kenneth Hermele, Nabi Kanta Jha, Sanna Händén-Svensson, Andreas Malm, Rikard Warlenius, Martin Oulu, Gregory Pierce, Sarah Kollnig, Cheryl Sjöström, Anna Kaijser and many more. Although most of the data for this thesis was collected from either dusty library books or through bright screens, there is no source to knowledge like real life. I thank the people I met on my travels in the Andes who showed me their world and made me feel at home there. I also thank Professor Luis Jaime Castillo for welcoming my family and me to the excavation site at San José de Moro in Peru.

Outside of the university, important people came into my life during this time *pachakuti* overturning my world; Annfinnur, and our two daughters Rannvá Píl and Bergtóra Glóð who make everything worthwhile. I thank my friends and family, too many to mention individually, who have been supportive in a number of ways.

Finally, I dedicate this book to my parents, my mother Bergtóra Hanusardóttir and my father Bogi Hansen. Although I have always been certain that the path I was following in life was my own, surely it cannot be a coincidence that I end up writing a thesis which is ultimately about ecological sustainability and human equality. I thank my father in particular for

discussing the mathematical aspects which are included in this thesis with me, and for reading and making useful comments to my text. Any remaining errors are of course my own. Whether in intellectual stimulation or in taking care of my children when I had to write I thank you both for your constant support and your stunning confidence in me whichever way I choose to take on this life.

1. Introduction

This thesis is a study of the appropriation of time and space in the Inka Empire. It is an attempt to estimate, in biophysical terms, the amount of time and space appropriated by one group of people, the Inka elite, from other groups of people, those which were colonized by the Inka state. As such it is a study of power and inequality in the Inka Empire. The issue of inequality has, most likely, pre-occupied the human mind for as long as human society has existed, but these questions seems increasingly pressing in a world where, in spite of unprecedented and fast accelerating and unsustainable resource use (Fischer-Kowalski and Haberl 2007; Giljum et al. 2015), wealth inequalities are aggravating (e.g. Piketty 2014). Indeed, although textiles, maize beer, and stone walls in the Inka Empire might at a first glance seem irrelevant to the discussion of inequality in our contemporary world, it is the aspiration to better understand the nature of inequality, which has motivated this research.

There are multiple ways to conceptualize study and measure the multifaceted phenomena of power and inequality, and analysis can be geared to multiple levels of scale ranging from the family or household to ethnic groups, social sectors of society or global inequalities between world regions. Generally, scholarly approaches are either phenomenological and focus on symbolic dimensions pertaining to matters of social, cultural or political identity, or to a material dimension pertaining to the unequal access or distribution of resources. This dualist focus on either the phenomenological or the material aspects of inequality often renders us unable to understand and critically reflect upon how power, and by extension, inequality "rests in the very relation between the material and the symbolic" (Hornborg 2016). In this work, inequality is understood as a materially and symbolically constituted process, inequality materializing through the ways humans materialize culture. This process can therefore be measured in biophysical units.

Attempts at measuring relations of inequality through quantifying resource distribution between different groups of people are not new, and in our

contemporary modern society inequality, as most other phenomena, is often measured in monetary terms. In this study, the socio-ecological processes of reproducing society, in this case Tawantinsuyu, the largest political formation ever to emerge in the prehispanic Americas, and known popularly as the Inka Empire, are measured in units of time (labor hours) and space (hectares of land).

Since the arrival of the first Europeans in Tawantinsuyu almost 500 years ago, Andean culture and civilization has fascinated and intrigued European observers and scholars. Because the "New World" developed in relative isolation from the "Old World", it has always inspired cross-cultural comparison. As Wachtel (1977:61) states, the Inka Empire as a "mirage" has been classified as many things. Julio C. Tello, the founding father of Peruvian archaeology referred to the Inka era as "the century of gold", and historian and anthropologist Luis E. Valcárcel called it a "nation of justice" (Dieterich 1982:111). Historian William Prescott (1847) dubbed it a system based on the "most absolute and terrible authority." The Inka Empire has been described as a socialist state in both utopian and dystopian terms (Baudin 1961[1928]; Cunow 1896; Marmontel 1777). It has been classified as a monarchy of the Asiatic model or Oriental Despotism (Wittfogel 1956; 1957), a feudal state, a slave-based society, and more. In short, it seems researchers have found in the Inka Empire - the mirror image of Western civilization - what they were looking for.

These perceptions of the Inka Empire of course reflect the theoretical and paradigmatic debates of their time. Today, as scholars struggle to do away with the Eurocentrism and evolutionism so intricately intertwined in Western and scientific knowledge production, researchers find evidence in the archaeological record of South America which contradict previously accepted evolutionary schemes and sequences of traditional models of "cultural development." Sedentism for instance was not universally a result of agriculture and vice versa (Isbell 2008a). Major investments in the landscape were not necessarily a result of population pressure (Hornborg et al. 2014; cf. Boserup 2005[1965]). Urbanism, state formation and monumental architecture could be achieved by people who would in other respects be classified as hunter-gatherers in the classic literature (Shady 2006; Isbell 2008a:1149), and so on.

This thesis will present yet another image of the Inka Empire. However, the aim is not so much to determine what Inka social, political, and economic

institutions were and to categorize or classify them. The aim is to study what these institutions *did*, or rather made people do, not so much what they appear to us to *be* (Godelier 1986:94). The method I use has been tentatively termed time-space appropriation analysis (Hornborg 2006a). It is developed within the larger theoretical and analytical framework of ecologically unequal exchange, and approaches the analysis of social systems from an ecological or biophysical perspective. By measuring aspects of social process in biophysical units, the aim is to know more, or at least something else, than the people involved in the processes themselves (Hornborg 2003).

As with most attempts at cross-cultural analysis, the ambition here is to learn something new about "the Other" as well as ourselves, using analytical tools to defamiliarize "phenomena that are so familiar to us that they seem natural or inevitable" (Marcus and Fischer 1999[1986]:137). From the very beginning of contact, European observers and writers have "demystified" Andean cultural, political and religious practices, perceptions and conceptualizations. One of the most influential historical sources on Inka society, the Jesuit priest Bernabe Cobo, writes of Inka religion that it was "so full of fabrication, hoaxes and absurdities that it is surprising to see how intelligent men could be persuaded to believe in it" (Cobo 1990[1653]:5). It is not without a certain measure of ambivalence that I enroll myself in this tradition. However, I depart from the premise that "[w]e live in as culturally constructed and non- 'natural' a reality as they" (Marcus and Fischer 1999[1986]:138), and my aim is not to deconstruct Andean belief systems, but rather to reconstruct them in order to see how they were related to economic processes. Since all human economies share the fundamental, biophysical and thermodynamic conditions set by this universe, understanding the recursive relation between these two "facts" of cultural construction and universal biophysical conditions is crucial for imagining what sustainability, equality, and justice can be in human societies.

In this work, I depart from the understanding that power "is a social relation built on an asymmetrical distribution of resources and risks" (Hornborg 2001:1), and that power entails unequal access to resources together with cultural mystification of such inequalities (Hornborg 2016). This is not only the case for modern capitalist power, but also for Inka power. Moreover, in modern as well as in Inka society, relations of power, that is social relations between people, "masquerade as relations to things." Included in this category of "things" are landscapes, commodities, money, and technology"

(ibid.). One way to study relations of power, and by extension again, inequality, is then to study the things which these relations materialize(d) into. As suggested by Appadurai, "[f]ocusing on the things that are exchanged rather than simply on the forms and functions of exchange, makes it possible to argue that what creates the link between exchange and value is *politics*..." (Appadurai 1986:3, emphasis in original).

The three case studies included in this thesis are studies of "things" or artifacts produced in the Inka Empire. In the case studies, the production processes of three emblematic Inka artifacts are reconstructed: textiles, *chicha* (maize beer), and stone walls, which were all of crucial importance to the Inka political economy. The questions approached in the case studies pertain to assessing and quantifying how much labor and land (time and space) the Inka appropriated through these production processes, from whom, and by which means Andean peoples were persuaded to participate in such practices, which continually reproduced their inferior position, both materially and symbolically, as subjects of the Inka lords. The main research questions can be articulated as follows:

How much labor and land were the Inka able to appropriate from their subjects through the imperial production of textiles, chicha*, and stone walls? How large a proportion of the Andean landscape and of people's daily lives was thus dominated by these elements of the Inka imperial economy?*

Using the method of time-space appropriation analysis it is estimated how much labor time and natural space was required to produce textiles, *chicha* and stone walls, and therefore embodied in these artifacts appropriated by the Inka state. It is demonstrated how the asymmetric exchange relations enabled the Inka elite to accumulate embodied time and space extracted from their subjects and to invest it in different forms of imperial capital. These capital investments again were used to facilitate and aggravate continued appropriation.

The aim with this thesis is threefold: Firstly, pertaining to social theory, the aim is to show that imperial power, exemplified here by the Inka, is based on biophysical/material flows of embodied labor and land, which is appropriated by the elite through various specific cultural permutations of reciprocity and redistribution. A second aim pertains to methodology, to show that these biophysical/material flows can be estimated on the basis of archaeological, historical, and ethnographic data, and the cultural ideologies controlling them

as well. Finally, applying these theoretical and methodological tools, a third aim is to contribute with specific insights on Inka social metabolism.

1.1 A note on orthography and the term "Inka"

Previously, most Andean words were written in Spanish orthography, but it is now more common to use Andean orthography, and write for instance Tawantinsuyu instead of Tahuantinsuyo, or *khipu* instead of *quipo*. It is however common to use "s" as a suffix after Quechua words to indicate their plural form, but in Quechua,[1] the language of the Inka and the lingua franca in the Inka Empire, the suffix "s" did not signify plurality. In Quechua, other suffices are used to signify plural form, such as *–kuna* in *runakuna*, *aqllakuna*, *mitmaqkuna* etc. I will therefore write Andean terms in their singular form, also when I am referring to them in plural, including the term "inka". The term Inka is commonly used to denote an empire, an ethnic group, a time period, a ruler and more; an Inka bridge, Inka terrace etc. Flores Ochoa (1977b) suggested that the term corresponds to the Andean concept of *enqa*, "source and origin of felicity, well-being, and abundance" (Staller 2008:275). By using this term about themselves, the Inka, and the Inka ruler in particular, were "attempting to center themselves in the metaphysical principle underlying this concept" (ibid., see also Zuidema 1983). To avoid confusion, when referring to the people who identified and were identified as Inka I will write "Inka", and when referring to the Inka ruler, or something else "Inka", I will specify this in the text.

1.2 Overview of thesis

Having given a brief introduction to the research questions and aims of this thesis, in section two, I present and discuss the theoretical and methodological framework. In section three, I briefly describe method and

[1] Quechua, and other Andean languages were not written languages, and since Quechua pronounciation was and still is not consistent throughout the Andes there is no generally accepted orthography. Most native words are therefore spelled in a variety of ways. For an overview of the historical development of Quechua see e.g. Mannheim (1991).

data, and discuss how time-space appropriation is related to issues of power and (in)equality. To provide a context for the case studies, section four is an overarching introduction to some of the most important and elemental aspects of the historical, cultural, social, political, and economic constitution of the Inka Empire. The three case studies of Inka artifacts: textiles, chicha, and stone walls, are presented in section five. In section six, the average ecological footprint of Andean agro-pastoralists is estimated and used, together with the results from the case studies, to assess the material flows of time and space which were transferred between people in the Inka Empire. Finally, the results are summarized in section seven.

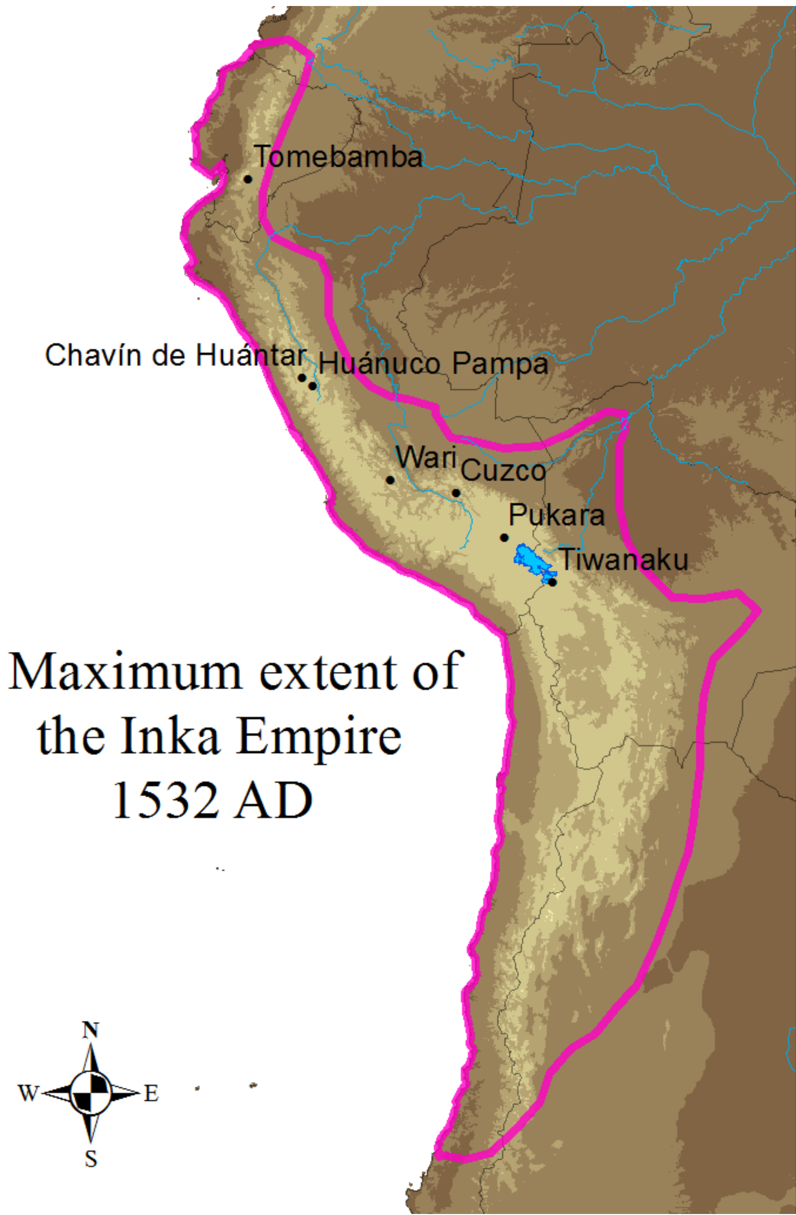

Figure 1.1.
Maximum extent of the Inka Empire (based on Covey 2008), showing some of the sites mentioned in the text.

2. Theoretical framework

This thesis on Inka imperial metabolism draws theoretically and methodologically on a range of fields and disciplines. It is fundamentally a study of human-environmental relations, and it deals with two basic research questions at the core of the human ecological research field: firstly, how people organize and structure society without destroying the natural environment; and secondly, how limited resources and environmental risks are distributed among people, sectors of society, world regions, and generations (Hornborg 1997). A key point of departure is that any adequate understanding of human-environmental relations requires a transdisciplinary approach, one which acknowledges the recursive interrelations between person, society, and nature – the mental, the social, and the material (Steiner 1993; Hornborg 2001:193).

The method of calculating time-space appropriation has been developed within the larger analytical framework of ecologically unequal exchange (Hornborg 1998; 2003; 2006a). It builds on the insights of world-systems analysis (Wallerstein 2011[1974]) and dependency theory (Frank 1967, 1979) that accumulation of wealth in core or central areas of the world is dependent on unequal trade relations with their peripheries. Time-space appropriation analysis is a tool to measure these relations in biophysical units of time and space, and as such it is also a way of reconceptualizing human economies as transfers of time and space between people.

Although the analytical framework of ecologically unequal exchange has been developed in an effort to identify ecologically unequal trade relations in the modern world-system, the method of time-space appropriation analysis is a cross-culturally applicable method for studying human economies, since all human economies ultimately rely on labor time and natural space. Time and space correspond to the two factors of production ”labor” and ”land,” which, together with capital, were defined as the sources of all wealth by the early political economists such as Adam Smith and David Ricardo. Although labor theories of value have led to a tendency to neglect other factors, Karl Marx

was clearly aware of the fact that even human labor is a metabolic process, and did not ascribe “supernatural creative power to labor," but defined it as a “manifestation of a force of nature, human labor power” (Marx 1970[1875]). Marx himself seems to have thought about economy mainly as economy of time,[2] but the ultimate implication of this insight is that human labor time can in fact be re-conceptualized in terms of embodied natural space, and vice versa.

It has been argued that the internal logic of all economic and social systems tends to be imagined as fair and just, as reciprocal systems of balance and symmetry (Graeber 2011:114). This was true of the Inka Empire, and it is true also of modern market society, where the market, if allowed to operate properly, is imagined to be “one vast network of reciprocal relations in which, in the end, the accounts balance and all debts are paid” (ibid., 115). Ever since economics emerged as a discipline, this notion has been challenged by so-called heterodox approaches to economics, and it is in these traditions that alternative methods for representing economic processes, such as time-space appropriation analysis, are rooted. Graeber (2011:112) further observes that “even if Medieval writers insisted on imagining society as a hierarchy in which priests pray for everyone, nobles fight for everyone, and peasants feed everyone, it never occurred to anyone to establish how many prayers or how much military protection was equivalent to a ton of wheat. Nor did anyone ever consider making such a calculation.” But precisely such conversions, although kept invisible, are fundamental to hierarchical societies. Although not with the aim of establishing value equivalents, time-space appropriation analysis is a tool to analyze such economic arrangements from a biophysical perspective, calculating how embodied time and space were transferred between people through hierarchical relations.

[2] “Economy of time, to this all economy ultimately reduces itself” (Marx 1973[1857]).

2.1 Imperialism

A review on the literature of ancient empires and the phenomenon of imperialism as such is far beyond the scope of this work. Yet, imperialism, in all its past and present manifestations, always entails domination and appropriation of people's time (labor) and natural space (land). Imperial projects therefore are about the control of energy flows (including human labor), whether through coercion, markets, tribute, gifts, or other exchange/distribution mechanisms. Imperialism, however, is equally much about the use and manipulation of cultural symbols and meanings, ideologically framing and justifying inequalities and domination. It has been remarked that although archaeologists "regularly speak in the abstract of increased amounts of material culture, increased energy consumption, exploitation, and other phenomena related to surplus production, we rarely take the time to systematically quantify these increases and reckon their effects on producers and consumers" (Costin 2015:46). Time-space appropriation analysis is here applied as a method for doing just that.

A central critique of conventional methods for describing and analyzing political economies in non-western as well as western societies is that they focus solely on what has been counted as "labor" in these cultures, and therefore have reinforced an understanding of these systems on their own terms (Mellor 1997; Graeber 2006). The method of time-space appropriation, however, provides a tool to assess not only what is culturally appropriate or conceivable to measure, but the biophysical process of production itself in as great detail as is feasible. It is in that capacity that the method of time-space appropriation aspires to the ambition of knowing "more about exchange than the participants in that exchange" (Hornborg 2003:9). The aim with the cases presented in this thesis is to illuminate and concretize both the ecological, or biophysical, aspects of particular cultural strategies of domination and exploitation in the Andes and the consequences of these strategies for Andean people and their livelihoods during the realm of the Inka. In other words, to study and understand the power of the "things" produced and exchanged in human economies, one needs also to study the landscapes whence they came and the people who made them.

Using the method of time-space appropriation analysis to investigate the environmental history of the Inka Empire implies a focus on the redistributive aspects of Inka imperialism (Hornborg 2007). By measuring

the requirements on labor and land involved in the Inka imperial economy it is possible to see how these two factors were transformed into different kinds of capital: goods and material infrastructure, some of which is still visible in the landscape, which was in turn reinvested in various imperial strategies to facilitate the continued appropriation of labor and land.

2.2 Social metabolism and Inka imperial metabolism

The term "social metabolism" refers to the biophysical flows constituting social systems. It is used, for instance, within the school of ecological economics, and is based on the recognition that economic processes are ecological processes and therefore appropriately studied from a physical point of view, in terms of flows of matter and energy (Martinez-Alier 2007:221). Although the embeddedness of human economies in nature has long been acknowledged, few historians have conducted systematic calculations of energy and material flows (ibid.). In recent decades, however, and in light of the growing concerns with the intensity and expansion of resource use and its ecological consequences, a number of analytical frameworks and methods have been developed to assess these processes from a biophysical perspective, e.g., ecological footprint analysis (Wackernagel and Rees 1996), material flow analysis (Fischer-Kowalski 1998), and human appropriation of net primary production (HANPP; see Vitousek et al. 1986; Haberl et al. 2007). Such flows can be assessed in different metrics such as weight, volume, energy content, human labor time, or hectares of bioproductive space.

Inka imperial metabolism thus refers to the biophysical flows which constituted the Inka Empire. It refers to a *thermodynamic* ecological process. In this sense, social or imperial metabolism is part of the larger metabolism of the Earth system, which is constantly converting and dissipating solar energy and thus reproducing life on Earth. Human labor constitutes only a fraction of the Earth system metabolism, but nevertheless a very important fraction, at least seen from a human perspective. Humans experience this thermodynamic biophysical process, the arrow of time, as "a flow of consciousness" (Georgescu-Roegen 1986:4), and in more than a symbolic way then, land or landscape is "time materialized, or better time materializing" (Bender 2002). This applies not only to landscapes in a

restricted sense of the term but to everything we associate with the phenomenon of life on this planet (cf. Prigogine 1997). Production and other economic activity does not simply "take place" in time and space. Rather, time and space is what constitutes the economic process, and the goods which result from it. Commodities, which appear to us so obviously material, are also embodiments of "time," not only in a philosophical sense of the word, but even a biophysical. Through their daily chores and activities the common people as much as the Inka elite reproduced the structures of ecologically unequal exchange that was Tawantinsuyu.

2.3 Capital accumulation in noncapitalist societies

In this thesis I identify some of the technologies through which the Inka elite appropriated natural space and human labor time from their subjects, and estimate how much of the available time and space was appropriated and accumulated in different forms of "capital." Capital accumulation is often understood and defined as a phenomenon unique to capitalism, as a specific form of accumulation characterizing capitalist societies. The dichotomy within much Marxist analysis between capitalist and non-capitalist societies rests on the idea that production in non-capitalist society was directed towards the "creation of distinctly useful goods," and was therefore a production of use value, not exchange value or surplus value (Booth 1991:10). As the economy seeks to satisfy needs rather than to maximize surplus value, this purpose "sets a threshold beyond which further labor is judged superfluous" (ibid.,11).

If capitalism is defined as a mode or relation of production which developed in Europe during the past three to five centuries, however, such propositions seem quite naïve. Andean history going back millennia attests to the investment of labor in goods and infrastructure that cannot in any way be said to be restricted to any meaningful notions of need or usefulness. As Bruce Trigger (1990) has demonstrated in a discussion of monumental architecture, the symbolism of power seems universally, not only in capitalist society, to be located exactly in the superfluous or conspicuous, precisely because it runs counter to the principle of economy of effort.

Capital accumulation in the most restricted definition of the term, involving the aggrandizement of monetary assets through profitable investment, can only take place within the capitalist mode of production. In this thesis, however, I apply a more general definition of capital accumulation as “a recursive relationship between some kind of technological infrastructure and a symbolic capacity to make claims on other people’s resources” (Hornborg 2016:224). This means looking at the Andean landscape as a result of cumulative processes of capital accumulation, in the form of imperial infrastructure as well as the environmental impacts of its production and reproduction, and analyzing how people were persuaded to invest their labor time and resources in these processes. It also implies rejecting the commonly perceived dichotomy between capitalist and non-capitalist economies, as in the notion that capitalism is unique in its ability to “occlude the discrepancies between the ecological transformation of matter and energy actually taking place and the refracted representation of this transformation as economic surplus production” (Altvater 1994:87). Here, too, the evidence from the Inka case seems to suggest otherwise. Processes of accumulation invariably rely on relations of ecologically unequal exchange, but these relations are just as invariably “occluded” through images of balance and reciprocity.

2.4 Historical political ecology

The Inka Empire, although the most famous and popularly known, was only the last in a long succession of regional political formations, from states to empires, to emerge in the Andes. There are several ways to divide the Andean past, but in accordance with the chronology proposed by John Rowe in the 1940’s Andean “civilization” is often divided into three “horizons” of political integration and cultural hegemony, with “intermediate” periods of political fragmentation in between.[3] The Early Horizon, dated between 900 and 200 BC, is associated with the Chavín culture, so named after the site of Chavín de Huántar, located in the Andean highlands. The following period is the Early Intermediate Period, dated to around 200 AD to 600 AD and associated with the Nasca culture on the south Peruvian coast and the Moche

[3] Other models for dividing Peruvian and Andean prehistory have been proposed by Lanning (1967) and Lumbreras (1974).

or Mochica in the north which are often classified as the first Andean state societies (Castillo and Uceda 2008). The Middle Horizon 600 AD to 1100 AD saw the ascent of the highland polities of Tiwanaku and Wari. The demise of Wari and Tiwanaku hegemony marked the beginning of the Late Intermediate Period around 1100 AD and finally the Late Horizon, dated to around 1438, and associated with the rule of the Inka Emperor Pachakuti and the Inka conquest of the coastal Chimú, corresponds to the apogee period of the Inka Empire, ending abruptly in 1532.

The Inka thus inherited both a highly cultured landscape and a long tradition of Andean statecraft from previous political projects. In the case of the Inka there are historical sources from the early colonial period, but otherwise, since these cultures left no written accounts that can be deciphered today, they are only known archaeologically. The primary source of knowledge about them is the imprints they have left in the landscape.

Figures 2.1 – 2.4. Cultural periods of the Andean region, and the major associated cultures and polities.

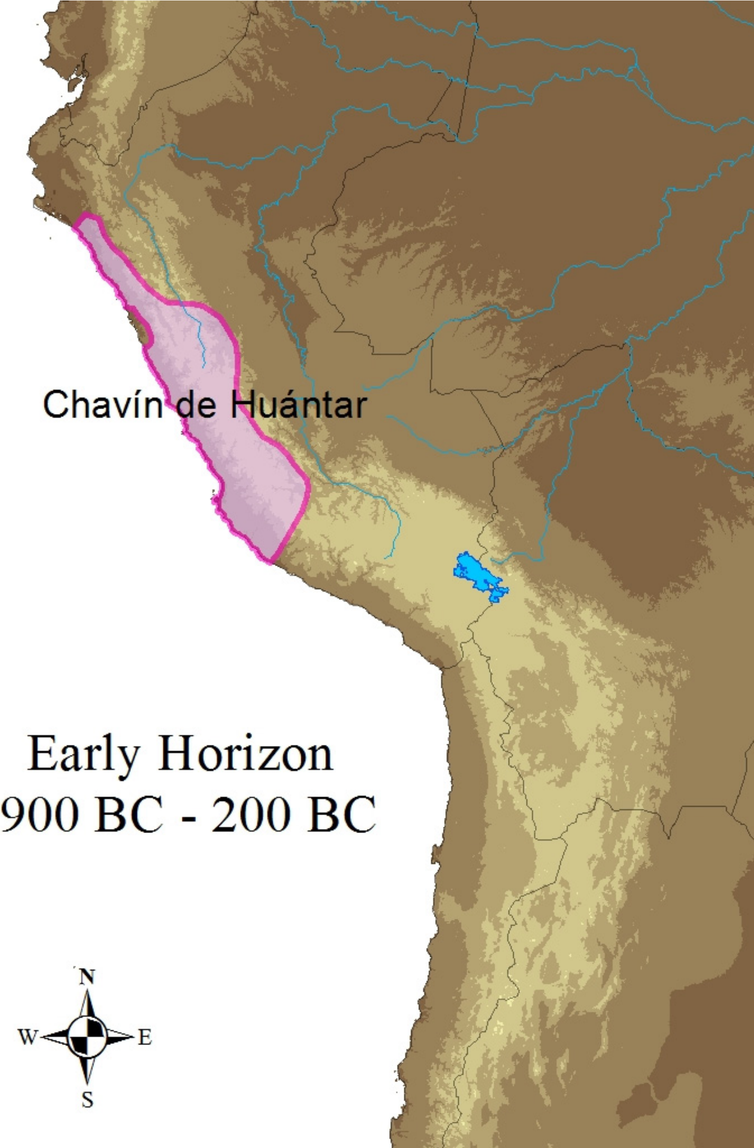

Figure 2.1
The Chavín sphere of influence. Based on Burger (1992, 2008).

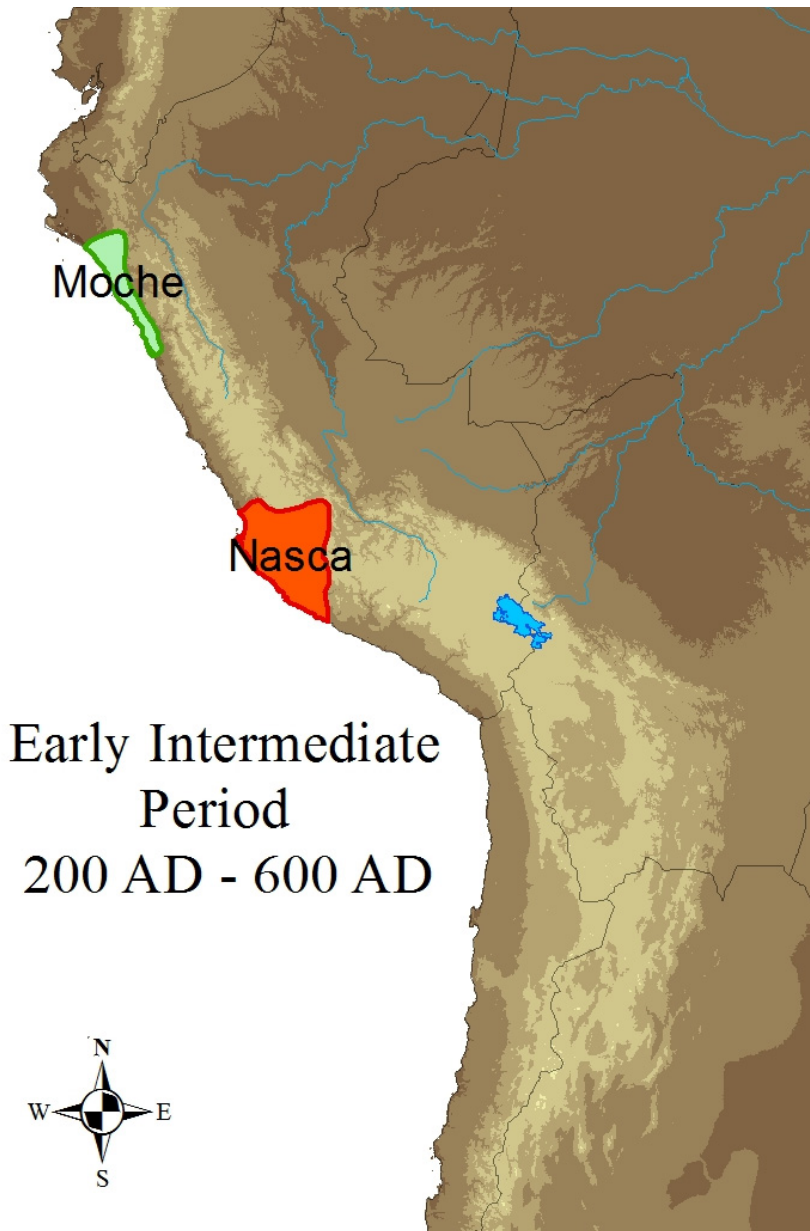

Figure 2.2
Based on Castillo and Uceda (2008:708) and Proulx (2008:564).

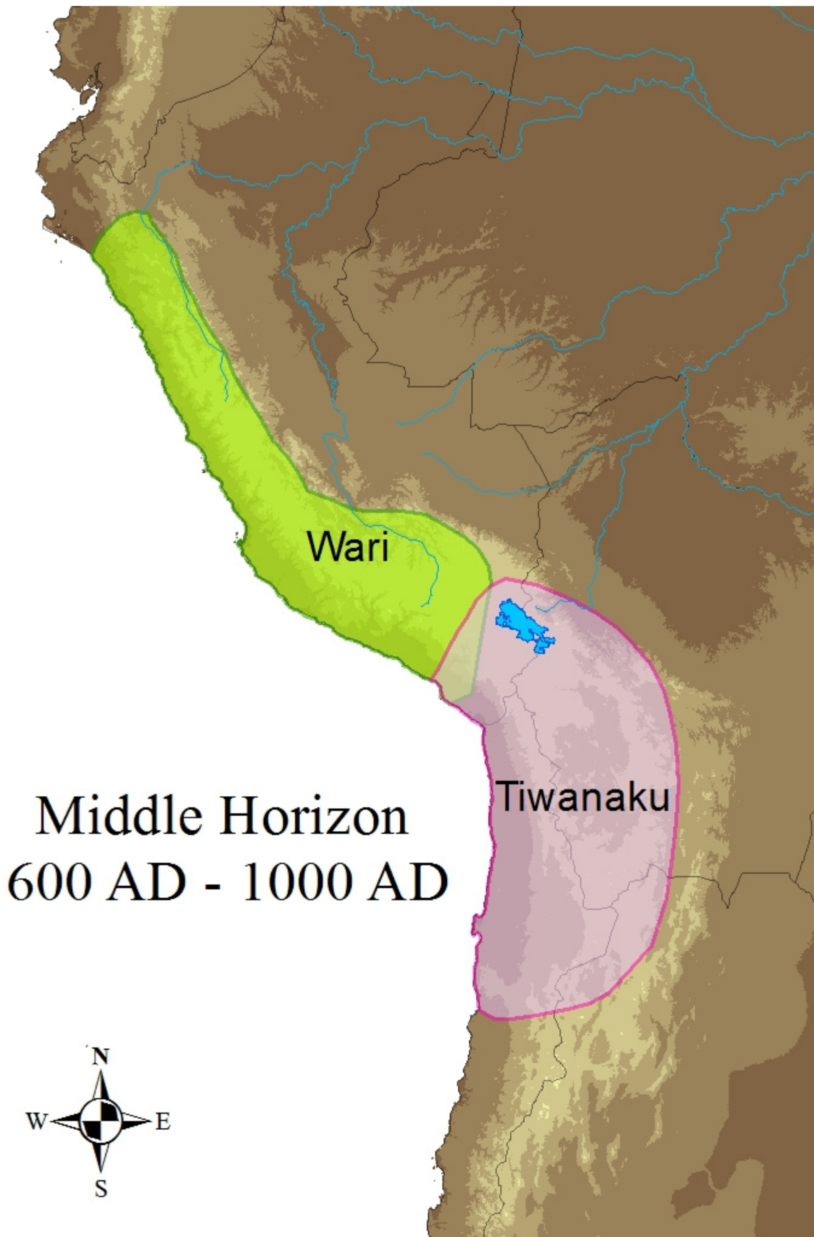

Figure 2.3.
Based on Isbell (2008b:733).

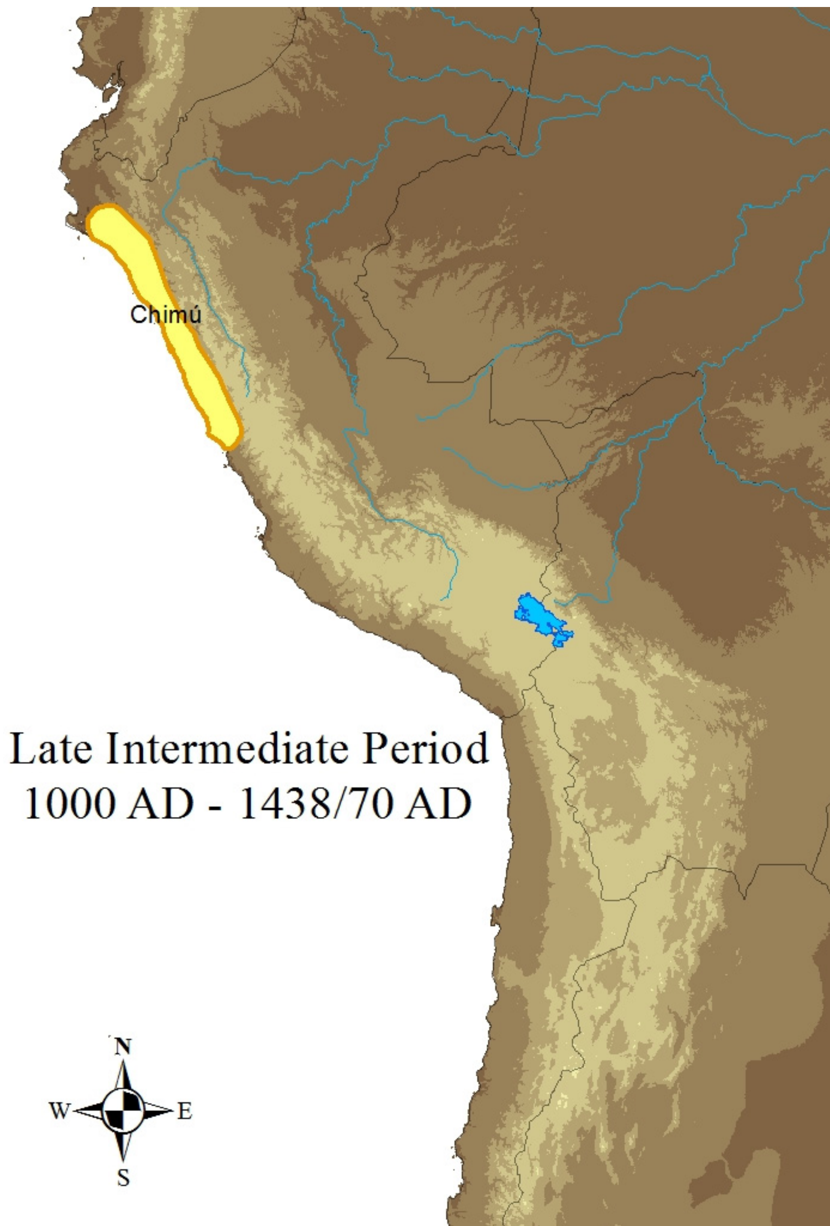

Figure 2.4
Based on Moore and Mackey (2008:788).

Recognizing patterns in landscapes and ancient material culture is the aim of archaeology, but traditionally, archaeology has been biased towards "surplus culture" or "civilization," that is, it has been predominantly preoccupied with artifacts or architecture which show signs of having had more than mere utilitarian value. Only more recently archaeologists have begun to study sites occupied by the "people without a prehistory" (Denevan 2001:295; cf. Wolf 1982). Also, the fields of environmental history and historical ecology have widened the focus on the landscapes which sustained ancient populations, studying landscapes as cultured, that is, as created by people through their socioeconomic activities (Erickson 2008; Crumley 1994). Historical ecology denies the often preconceived premise that the "progress" of human societies is causally linked to environmental destruction, and a rich body of research has emerged documenting the multiple ways in which human cultures have organized themselves socioecologically and investigating the implications for sustainability (Swetnam et al. 1999; Cleary 2001; Balée and Erickson 2006; Isendahl and Smith 2013). The research process of historical ecology has been described as a form of "reverse engineering" (Erickson 2008:159), where physical patterns in landscapes through careful analysis can provide insights on the original logic and human intentionality which generated them. Such "reading of landscapes" can be a useful approach in social science, revealing power relations that are not otherwise evident to social scientists and historians using other sources (Widgren 2010:71). To illustrate this point we may consider how cultural preferences for certain commodities in one part of the world, say sugar, coffee or metals, shape landscapes in other parts of the world. Such global power structures are intimately related to identity construction, often historically rooted and deeply embedded in cultural practices, and determine how landscapes are used and by whom.

If power structures shape landscapes, then of course landscapes can tell us something about power structures. Widgren (2004, 2010) has suggested that a cross-cultural comparative understanding of landscapes must be based on three different conceptualizations of the term. Firstly, landscape as scenery or representation, that is, a mental construction or a "way of seeing." What is seen in a landscape differs according to what people know and value. Secondly, landscape as institution, which does not focus on the physical or cognitive appearance of landscapes but on the people of that land and the social institutions that govern it. Thirdly, landscape as land, which transformed by labor, serves as a basis for both biological production and the accumulation of wealth. These three approaches or conceptualizations and

research traditions in landscape studies correspond to the ambition of human ecological research to study the mental, the social, and the material dimensions of human-environmental relations. In reality, of course, these three conceptualizations of landscape are intermeshed, overlapping and recursively related. However, they may serve as a useful template in structuring a discussion on the Andean landscape.

When it comes to the first landscape concept as "a way of seeing," we have written accounts from the Spanish conquistadores that relate how the Spanish perceived what they saw upon their arrival in the Andes. Keeping in mind the "volatility of landscapes" and the fact that even one person "may, more or less in the same breath, understand a landscape in a dozen different ways" (Bender 2002:106), there are clear indications that Andeans saw and experienced their landscapes in ways fundamentally different from the invaders. It is clear from ethnographic as well as ethnohistoric documentation that the modernist tendency to separate emotions, symbolic meanings, moral sentiments, and intuitions from place was not common among traditional Andeans (Moore 2005). To the native inhabitants, Andean landscapes were imbued with meanings and values that were beyond the grasp of the Spanish invaders and chroniclers and which we can only hope to catch a faint reflection of through the historical and archaeological sources available.

From a social perspective, political and social organization was also inscribed in the landscape. In fact, the dominant model of Andean political and economic life, commonly referred to as complementarity, suggests that the "Andean way" was a unique adaptation to the ecological conditions of the central Andes. Irrigation systems were recognized as political borders (Sherbondy 1987), and the principle of dual organization, for instance, was manifested in the built landscape in settlement hierarchies etc.

Finally, landscape is land in the economic sense of the word. The incredibly varied Andean landscape unquestionably presented challenges, but also opportunities. Through the millennia, Andeans domesticated a wide variety of crops and also two camelid species (llama and alpaca) which were of immense economic importance, and which efficiently converted solar energy into fibers, fuel and calories suited for human consumption (A. Morris 1999). In addition, landscape modifications or landesque capital (see Håkansson and Widgren 2014) in the form of terraces, raised fields, sunken fields, etc., which increased the productivity of land, were almost ubiquitous in the Andean landscape.

2.5 Economic anthropology

Through the work of John V. Murra, Polanyi's substantivist view of economy has greatly influenced the understanding of Andean culture and society, as Murra was highly influenced by Polanyi's perspective when he first articulated the model of "vertical archipelago" in 1972 (Stanish 1992; Wachtel 1981). Polanyi argued that in non-market societies, exchange was embedded in non-market institutions such as kinship, religion, and politics. In his influential book *The Great Transformation* (1944), Polanyi wrote that prior to what he called "Market Society," all human societies "were organized either on the principles of reciprocity or redistribution, or householding, or some combination of the three" (1944:54-55). In *Trade and Market in the Early Empires*, Polanyi (1957:250) identified three forms of integration: reciprocity, redistribution, and exchange. The former two were characteristic of premodern society, whereas exchange was characteristic of modern market economies. Polanyi described the Inka Empire as a civilization "of vast economic achievement" and a society where "an elaborate division of labor was worked by the mechanism of redistribution" (Polanyi 1944:52). Redistribution referred to the movement of the products of land and labor in toward a center (in the form of taxes, tribute, gifts, etc.) and out again in forms which the central power saw fit.

Polanyi opened up the possibility to describe the socioeconomic systems of non-Western societies on their own terms, and his views became highly influential in anthropology and archaeology. According to Stanish (1992:4), Murra's model became the all-dominating paradigm for understanding prehispanic economic and political processes in the southern zone of the central Andes, and evolved from a hypothetical model of land tenure, to an "ideal which claims to be fundamental in understanding indigenous Andean cultural reality." Although the understanding of zonal complementarity as a process predicated on the uniquely "vertical" Andean landscape has been rejected (Stanish 2003:213), redistribution and reciprocity are still seen as the principal mechanisms governing economic exchange in the Andes.

2.5.1 Reciprocity and moral principles of exchange

Reciprocity has been a central term in economic anthropology from its earliest times, with the works of Bronislaw Malinowski on the *kula* exchange of the Trobriand Islanders and Marcel Mauss' (1990[1925]) famous essay on "The Gift." From the very beginning, the principle and nature of reciprocity was studied as the alternative to market-based exchange, and within anthropology the term has come to signify non-market, or precapitalist, exchange of goods and labor. Reciprocity is also the term most commonly used to describe the traditional Andean economy, but it is not always very clearly stated what is meant by the term. It can be taken to refer to the practice of labor exchange between members of the community or *ayllu*[4] (e.g. Alberti and Mayer 1974), or it can be used to refer to central Andean socioeconomic systems in general, including the Inka Empire. Rostworowski, for instance, who has documented the existence of trade and markets in the coastal regions of the Andes prior to and during the Inka period (Rostworowski 1977), writes that in the absence of money and coinage, the imperial Inka economy was based on "reciprocal exchange of services and goods, a socioeconomic system regulating services at various levels and piloting the production and distribution of goods" (Rostworowski 2000:144,177). In this view, the Inka built on a traditional system of reciprocity and expanded it on an imperial scale.

Marshall Sahlins (2007[1972]) expanded on the notion of reciprocity by proposing that there are three main forms of reciprocity: generalized, balanced, and negative. According to Sahlins, redistribution is based on reciprocity since it is really a highly organized "system of reciprocities" (Sahlins 2007[1972]:188,208-9). Sahlins (2007[1972]:209) perceives the difference between reciprocity and redistribution as one of social evolution, which hinged on whether or not leadership is inherited. What kind of reciprocity is at play is determined by the social (e.g., kinship) relations between exchange partners.

More recently, David Graeber has argued that the concept of reciprocity "as currently used can mean almost anything" and is therefore "close to meaningless" (Graeber 2001:217). The reason why we seem to phrase everything in terms of reciprocity, argues Graeber (2011:114) is that

[4] *Ayllu* is the term for Andean kingroups. See more in section four.

reciprocity is the main way we imagine justice. When imagining a just society it is hard not to evoke images of balance and symmetry, but the fact that both tribute payments and their redistribution by the Inka were apparently represented as a reciprocal exchange of gifts does not say very much about the nature of exchange.

Graeber instead talks about open and closed reciprocity (Graeber 2001:220), and elsewhere (Graeber 2011:89-118), has suggested that a more fruitful way of approaching the issue of economic life and human economies in general is to recognize that economic exchange in any culture or society is guided by three universal moral principles, which are constantly at play: communism, exchange, and hierarchy. The principle of communism here does not refer to what is often connoted by the word, i.e., the "communist" regimes of the twentieth century or the collective ownership of the means of production, but human relationships which operate on the principle of "from each according to their abilities, to each according to their needs." Graeber does not equate this principle with reciprocity since the point is not that equal favors will be returned, but that the people involved know that the other person *would* return the same favor, not necessarily that he or she *will*, and no accounts need therefore be kept. Exchange, on the other hand, is about equivalence. As Graeber (ibid.) writes, it is "a back and forth process involving two sides in which each side gives as good as it gets." Finally, hierarchy is a relation between "at least two parties in which one is considered superior to the other." Although such relations are often represented in reciprocal terms, in practice, "hierarchy tends to work by a logic of precedent." Again, these principles do not pertain to different kinds of society, but operate in any society at any time, with people "switching between modalities" more or less all the time (ibid.).

The moral principles identified by Graeber can easily be recognized in the Andes. The sharing of favors without keeping accounts corresponds roughly to Sahlins' generalized reciprocity and, in an Andean cultural context, evokes the notion of *yanapay*. In symmetrical or balanced exchange the notion of *ayni* is evoked and hierarchy in *mink'a*.[5] Much as Graeber argues, in contemporary Andean communities, people seem to be constantly "switching between these modalities." *Yanapay* is the term for the principle guiding

[5] These terms and their exact meaning vary between regions and groups in the Andes. *Ayni,* for instance, is sometimes referred to as *waje waje* (D'Altroy 2015:101).

close (albeit often hierarchical) family relations between, for instance, parent and child or husband and wife (Mayer 2002:131), and there is, in principle, no counting of favors. *Yanapay* can be translated as “help” (Pozo 2002), and connotes “general assistance” (Sallnow 1987) or “aid given freely” (Allen 2002[1988]:72). *Ayni* guides relations between status equals, and a favor is exchanged for an exact equivalent, a day of labor for another day of labor for instance, whereas *mink’a* guides relations between status unequals, where work is reciprocated with something else. In the Andes *mink’a* is often likened to wage labor, and often tends to turn into wage labor (Mayer 2002:112). Whether one principle or the other is evoked depends not only on the nature of the event, but also on the status or identity of the participants. At one and the same event, a work party gathered to build a house or plant a field, some participants might do *yanapay* others *mink’a* and *ayni.*

While both *ayni* and *mink’a* in the literature are perceived as forms of reciprocity, Graeber argues that hierarchy (here: *mink’a*) operates by a principle that is the very opposite of reciprocity, it works by custom. That is to say, what people do once or twice tends to be treated as custom, which means they are morally obliged to continue doing it. Such arrangements, moreover, have historically tended to turn into a logic of caste, and people identify with what they do, e.g., as weavers, brewers, soldiers, and so on (Graeber 2011:111). The social categories that developed in the Inka Empire, e.g., *mitmaqkuna, yanakuna, aqllakuna/mamakuna*, and the *kamayuqkuna*, are examples of the creation of “fundamentally different human beings” (ibid.). [6] This operation requires that people are severed from their local context, a strategy which the Inka state applied on a monumental scale by relocating entire communities as *mitmaqkuna* or turning individuals or entire communities into *yanakuna*.[7] Other categories of people were also removed

[6] *Mitmaqkuna* is derived from the Quechua, term “*mitmaq*” which means “to spread” (Bonavia 2000:226, note 29). The *–kuna* suffix indicates plurality for nouns in Quechua. The term refers to colonists sent from ethnic groups to work at administrative centers, to farm land for the Inka state, or to man Inka military garrisons. *Yanakuna* were servants, sometimes described as slaves, *aqlla*- and *mamakuna* were women secluded in *aqllawasi* (house of *aqlla*) working for the Inka state and *kamayuqkuna* were specialist workers. See more in section four.

[7] From the perspective of the Inka subjects, they were not of course powerless and/or mindless producers transformed by the Inka system. The social categories in the Inka Empire could to some extent be negotiated and manipulated by individual actors, and it is often remarked that *yana* for instance could achieve high status in Inka society. From an imperial

from their local context, as when girls and women were relocated in the *aqllawasi* and weavers and potters in workshop colonies such as the one in Milliraya (Spurling 1992).

This definition of reciprocity as a principle of exchange between people who have the potential to be equals, *ayni*, corresponding to balanced reciprocity in Sahlins' terminology, was the one principle which the Inka did *not* try to evoke in their relations with their subjects, quite simply because that would have implied formal equality and suggested that the exchange was taking place between similar kinds of people. Although there is often an implicit understanding in writings and analyses of Andean society that *ayni* was the basic form of labor exchange in Andean communities, this understanding has been challenged by Rostworowski (1977:343) and Gose (2006) who argue that the principle of *mink'a* was in all probability the most common form of labor exchange in prehispanic communities.

2.5.2 Ideologies of reciprocity and their materialization

It seems that when we talk about reciprocity we are not so much talking about the material dimensions of exchange as its cultural framings. By measuring the embodied time and space appropriated by the Inka state through tribute obligations, it can be established that Inka subjects were participating in economic activities which systematically exploited their labor time as well as their land-based resources, through the systematic transfer of embodied labor and land to the Inka elite. What persuaded them to participate in this process?

The issue of dominance and cooperative behavior has been a matter of some dispute in the case of the Inka Empire. Anthropologist Maurice Godelier has promoted the view that dominated and dominant alike are participating in exploitative systems because they share the ideologies which legitimize and naturalize the exploitative relations (Godelier 1977:85; 1986). Godelier (1986:31) has argued that, to members of Inka society, the Inka emperor controlled the conditions of reproduction of both nature and society, and as the son of the Sun he could "guarantee the fertility of both the fields and of women":

---

perspective however, the institutionalization of such social identities or categories of people was a crucial element in controlling and directing their actions.

> Indeed, the belief in the supernatural efficacy of the Inca – common to the dominated peasantry and the dominant class alike – was one of the main sources of the dependence which, in the case of the peasants, informed their relation with the Inca and the State. Once each individual or local community thought it owed its existence to the supernatural power of the Inca, they felt obliged to supply him with labour and produce to glorify him and repay part of what he had done (in manner which is predominantly symbolic and imaginary for us) to ensure the reproduction and prosperity of all… Indeed the dependence recognized by the Indian peasant vis-à-vis the Inca at once founded and legitimized the unequal access of both parties to the means of production and social wealth (Godelier 1986:32-33).

Others have argued that Inka ideologies were not generally accepted by Inka subjects, at least not by all. D'Altroy (2015:115) states, for example, that the guise of shared responsibilities under which the Inka reorganized the Andean landscape was rejected by many Andean subjects, an argument he substantiates with the opposition many groups mobilized when the Spaniards arrived. Gose (2000:85) has likewise questioned the idea presented by Godelier that an Inka ideology of reciprocity was a successful attempt to obscure the exploitation of its tributaries. However, these conflicting views are not necessarily mutually exclusive if we accept that both dominance and cooperative behaviors are present in all human societies (Price and Feinman 2010:5), and that people do not necessarily have to believe in ideologies in order to reproduce or materialize them in their everyday lives.

This question of how ideologies become shared was approached from a slightly different angle in a key publication by DeMarrais, Earle and Castillo (1996) on "Ideology, Materialization, and Power Strategies." From an archaeological perspective, the authors ask what gives primacy of one ideology over another, and how an ideology supporting domination can be sustained in the presence of an ideology of resistance. The answer, they claim, "is grounded in the processes by which these ideologies are given concrete, physical form… Ideology becomes an important source of social power when it can be given material form and controlled by a dominant group" (DeMarrais et al. 1996:15).

This process, which the authors call the materialization of ideology, is part of the larger process of materialization of culture, that is, the ongoing process of creating and negotiating meaning. Ideology must be given "concrete form in order to be part of the human culture that is broadly shared by members of a society. This process of materialization makes it possible to control,

manipulate, and extend ideology beyond the local group" (DeMarrais et al. 1996:15). In other words, groups which have the means of materializing their ideology are able to mold "individual beliefs for collective social action" and to "organize and give meaning to the external world," processes which will over time create a shared political culture (ibid., 17). Identifying four "means of materialization" (ceremonial events, symbolic objects, public monuments, and writing systems), DeMarrais discusses the most important strategies for materialization of ideology in the Inka Empire. Some of these forms were ceremonial feasting, closely associated with *chicha*, symbolic objects such as textiles, metals and *Spondylus*, and the built landscape, roads and ritual spaces, including the fine stone masonry which materialized the Inka presence in the landscape.

It is precisely the material dimension of these processes which is measured in the analyses of time-space appropriation in the case studies of textiles, *chicha*, and stone walls in this thesis. Such analysis thus enables us to establish the discrepancies between ideologies and their material impacts on people and the environment.

One of the most obvious ways in which the process of materialization takes place is through crafting, a process through which "artisans create themselves, create objects, and create a network of relationships deeply infused with social and cultural meaning" (Costin 1998b:6), but the process of materialization can simultaneously be a process of destruction, as has been archaeologically documented at the site of Wat'a in the Ollantaytambo area in the vicinity of Cuzco (Kosiba 2012). At this site, in the early Inka period, an Inka plaza was constructed on top of the former elite residential area. The former structures were destroyed, and the fine decorated pottery of Wat'a smashed, burned and used in the foundation of the new plaza. Additionally there is evidence that this work was carried out by the local people themselves:

> In destroying pre-Inka buildings, local people concealed their own past. In raising Inka buildings, they defined the political authority to which they were subject. They built the walls that kept them out. They marked the social boundaries of a new world order (Kosiba 2012:125).

> In rebuilding Wat'a, they were reclassified as abstract and commensurable 'workers' in a manner that would become iconic of incorporation into the Inka state – namely through their labor (ibid.,124).

It is crucial to remember that although the Inka state apparently preferred peaceful incorporation to military conquest, all these strategies of materialization were backed by military force and the threat of violence; this was enacted in ritual and ceremonial feasting for instance, where the hides of dissident enemies were used as drums, and their skulls as drinking cups for *chicha*. It has been argued that "[a] key goal of imperial ideology, of course, is to normalize the abnormal—abnormal being the political circumstance in which a group from afar takes ownership of someone else's territory and at least part of their identity" (Stanish 2012:131). This normalization process largely seems to hinge on representing the abnormal relations as *things*.

3. Methods and perspectives

3.1 Data and limitations

For the historical and ethnoarchaeological descriptions in this thesis on the Inka Empire and traditional Andean society I have relied on the archaeological, ethnoarchaeological, ethnographic, and historical sources available. The theoretical perspectives framing my analysis of time-space appropriation in the Inka Empire draw mainly on the analytical frameworks of ecological economics, economic anthropology, and political ecology.

The method of time-space appropriation applied here to assess ecologically unequal exchange in the Inka Empire, was developed by Hornborg (2006a) to demonstrate the land and labor requirements of the early Industrial Revolution, which implied a systematic appropriation of resources from the African and American continents. While the Industrial Revolution is traditionally considered to be a European "innovation" such analysis shows that the historical phenomenon of industrialization can only be properly understood in its global context. The lack of statistics and historical documentation in the Inka case means that the data need to be reconstructed by other means, and the data used in the case studies to estimate how much land and labor was embodied in Inka artifacts have been collected from a wide variety of sources covering several disciplines, including archaeology, ethnoarchaeology, ethnography, geography, biology, and ecology. I have relied mostly on published research with the aim of synthesizing this material in a single analysis.

The three manufacturing processes that are reconstructed in the case studies were chosen primarily because they were of crucial importance to the Inka economy, comprising a significant part of Inka imperial metabolism. A second consideration was the availability of previous research to build on, as there is a significant body of literature on Inka textile, *chicha* and stone masonry. By choosing to focus on these three very tangible artifacts I do,

however, not mean to reproduce the notion which has been referred to as “naïve materialism” (Graeber 2006:69), which implies the understanding that material production is limited to the production of valuable material objects, and which therefore easily leads to a similarly naïve understanding of economy as being basically about the production and distribution of these material objects between people and classes (ibid.). In principle, the analysis of time-space appropriation could be based on other forms of materialization such as account keeping or rituals of mourning or reverence of an emperor for example.

Fortunately, earlier studies of labor requirements in the Andes are numerous, both when it comes to labor input in agriculture, construction work and crafting. More recently, studies of the land and labor requirements of *chicha* and textile production and their role in the political economy and ecology of Andean societies have been published (e.g. Jennings 2005; Costin 2015), and while the method and scale of the present analysis varies from these studies, the hope is to contribute to this line of research.

Most of what is known about Andean culture and society before the European invasion is based on a combination of archaeological, ethnographic, and historical research. The Inka Empire is a special case, however, since in contrast to many other ancient empires there is no written documentation from pre-conquest times available to us (Salomon 2015:23). Almost all historical information on the Inka Empire is mediated through some other cultural lens than the Inka one. An exceptional case of a text articulated from a native perspective and in Quechua is the Huarochirí manuscript, which was written around 1608 and the “immediacy, strangeness and beauty” (Salomon and Urioste 1991:1) of which gives a unique insight into prehispanic Andean thought. Another invaluable source to knowledge about Inka culture and society is the manuscript by Guaman Poma, which contains not only written testimony but also illustrations of Inka life. Felipe Guaman Poma de Ayala himself was born after the European invasion, but was of noble Andean heritage, and was a native speaker of several Andean languages. His insight into indigenous culture and thought is therefore considered unique among the chroniclers. Otherwise, most of the early chroniclers were either soldiers or priests or both, but the chronicles make up only a fraction of the historical material from the early colonial period. Legal documents from numerous court cases involving local people provide indigenous testimony, and the so-called *visitas*, which were carried out by

Spanish officials to ascertain demography, resources, productive systems, and customary laws, have provided insight on the Inka tribute system as well as *khipu*[8] recording techniques. The so-called "extirpation of idolatries," a Spanish effort to root out indigenous religion and ritual practices, also led to much information being recorded about religious beliefs.[9]

With a few exceptions I have not consulted the primary historical sources, i.e., the chronicles, *visitas*, etc. Because of the bias and often contradictory and misleading information in the primary sources, I have found it more adequate to rely on the interpretations provided by Andean scholars knowledgeable in their specific fields and better equipped to judge the reliability of the sources.

Fortunately, although the Inka Empire is almost 500 years distant in time, and although the devastation brought on indigenous Andean society by the European invasion can hardly be overstated, there is an overwhelming amount of research material available on Inka culture and society. Navigating this material can be a challenge, however, and considering the large volumes of research conducted within the fields which are relevant to my project, there will most certainly be some important sources I have missed, which could have made the picture more complete and improved my analysis.

Another aspect which should be emphasized is that although I will analyze Andean production processes in metrics of hectares, hours, calories, liters and so on, I am in no way suggesting that native Andeans perceived of these processes in such way. Applying the method of time-space appropriation analysis on Inka society necessarily means a reduction of aspects, dimensions, nuances and variation of a reality that cannot be included in the analysis. The numbers I arrive at do not exhaust the prehispanic Andean reality in all its diversity and complexity. They reflect as accurate an estimate of the biophysical requirements of production as the available material has allowed. At the most general level, the estimates illustrate that any economic process requires time and space, which therefore becomes unavailable for alternative processes. How much time and space is required to materialize a particular good or service depends critically on how social and economic

[8] *Khipu* were knotted strings made from cotton or camelid fleece and used to store numerical and perhaps also other information.

[9] For a comprehensive overview of documentary sources see Pillsbury (2008).

relations are organized. Needless to say, the effect on people's lives and their environments will vary accordingly.

Because of the thermodynamic nature of economic processes, measuring time-space appropriation will always be a heuristic exercise, as what is measured is in constant flux; the production processes recreated in these cases are not merely practices taking place *in* space and time, they *are* space and time *taking place*. I thus invite readers to reflect critically and imaginatively on the figures presented in the case studies.

3.2 Time, space and energy

The concepts of time and space arguably comprise the totality of existence. Space, from an earthly perspective at least, is the surface of the planet which changes with the flow of time. Earth's matter is constant as is the rate of solar energy which reaches its surface. The transformation of this essential energy flow reaching the Earth is closely associated with what humans experience as time, and is synonymous with everything we associate with life on Earth. Human as well as social metabolism is fueled through this flow.

Depending on a number of factors such as quality of land, climatic and geological conditions, and technology, humans can harvest useful chemical energy from the sun through the landscape. Previous research has suggested that prehispanic American civilizations such as the Aztec in the Basin of Mexico and Tiwanaku in the Titicaca Basin could sustain an average density of four persons per hectare (Smil 1994:65; Denevan 1982),[10] while hunter-gatherer societies generally use space much more extensively (cf. Sahlins 2007[1972]). "Civilization" in this perspective is largely synonymous with increased energy use.

One of the central tenets of anthropological models of cultural evolution is that as human societies evolve, they become more efficient at harnessing the solar energy flow for their own purposes (Sahlins 2007[1972]). The evolution of human economies is often understood as an increase in resource intensification, facilitated through different modes of production (Fischer-

[10] Estimates vary dramatically. Erickson has calculated a significantly higher yield per hectare for the raised fields in Titicaca.

Kowalski and Haberl 1997). "Economic development" is understood as a process where an increase in productivity per unit of land is achieved together with a decrease in the efficiency of production (Boserup 2005[1965]; Earle 1980). In other words, a greater surplus can be achieved through intensification, but at the cost of a higher input of human labor. The general driver of this process is often implicitly or explicitly understood to be population pressure, or simply the arrow of time, that is evolution itself. This explanatory model tends to represent "economic development" as a collective human struggle for survival and prosperity, rather than to focus on distributional aspects of economic processes.

An alternative perspective proposes that resource intensification is more likely driven by the aspirations of elites to enrich themselves through trade and surplus production. Such aspirations moreover may ultimately not be rooted in a desire for an increase in the production of valuables or resources, but in identity creation, i.e., in the production of people (Hayden 1995; Graeber 2006; cf. Costin 1998b).

3.3 Time, space and inequality

Social inequality has been projected back to the very roots of our humanity, as it has been argued that the essence of being "human" is not so much the capacity for symbolic thought in itself as the use of symbolism to organize human behavior (Henshilwood and Marean 2003:635). Both egalitarianism and hereditary inequality therefore require modern human cognitive capacities in the form of "symboling" (Ames 2010:37). Such behavior can be distinguished in the archaeological record "by a symbolic use of space and material culture to define social relationships, including significant groupings based on attributes such as kinship, gender, age or skill. Symbolism maintains, negotiates, legitimizes, and transmits such relationships" (Wadley 2001:201).

This might explain why "archaeologists seem to find the onset of inequality where they start looking" (Price and Feinman 2010:2), and suggests that inequality "in some form or another has always been present in human society, albeit largely suppressed among various groups of hunter-gatherers" (ibid.,3). Likewise it seems that "differential access to resources, including

food, health and reproduction can persist in egalitarian societies in the absence of an overt or visible political economy" (Ames 2010:32). Power and inequality in this sense must be understood as ubiquitously present in every human society, as continuous processes constantly negotiated and reinvented through human action, or in other words, through the materialization of culture. Early evidence of such symbolism is found in the extrasomatic storage of symbols, such as artwork and jewelry. Regardless of their original meaning, they materialize attention and provide potential avenues for competition (ibid.). Egalitarianism therefore requires a constant repression of competition and hierarchy (Graeber 2011; Ames 2010:37), in the same way as social hierarchy must be constantly reenacted and reinforced.

Inequality, viewed as the differential distribution of resources and risks (Hornborg 2001), cannot simply be understood to be rooted in certain "modes of production," as human populations are transformed from an egalitarian hunting-and-gathering way of life to a hierarchical society, from Stone Age economics (Sahlins 2007[1972]) to Bronze Age economics (Earle 2002), and so on. Graeber (2011) has argued that rather than having anything to do with mode of production, one of the characteristics of egalitarian morality is that people have no inclination to measure or calculate what other people owe them. It is not that people in egalitarian societies are unable to measure debts, that is, to compare things mathematically. Quite on the contrary, it is because people are well aware of their own ability to calculate debt, and of the inter-human relations this might lead to, that they tend to refuse to do so on moral grounds (Graeber 2011:79). The difference between a favor and a debt, according to Graber, is that debts can be specified and calculated precisely, and such accounting systems, argues Graeber (2001:14, 386-87), can only be upheld through violence. Information from the chroniclers suggests that debts in the Inka Empire could indeed be specified and calculated precisely. The accepted unit in which the Inka state collected debts was time, but as time and space are "integral to each other" (Munn 1992:94), whether debts are collected in units of time or kind, it will always entail the appropriation of both. The cultural occlusion of this fact is largely dependent upon cultural perceptions of time and space.

3.4 Time and space in the Andes - *Pacha*

The concepts of time and space in the Andes are aspects of Andean cosmology which have long intrigued Western observers. Skar (1993[1981]:32) writes that in Quechua "time and space are designated by one and the same concept: pacha. …the universe of time and space somehow merging into a single conceptual unit." *Pacha* is described as an "untranslatable word that simultaneously denotes a moment or interval in time and locus or extension in space" (Salomon and Urioste 1991) and which was also the name of the Earth in general. Time and space therefore are not separate conceptual abstractions "but are the only aspects of one and the same phenomenon" (Skar 1993[1981]:32). *Pacha* is sometimes translated as time-space, connoting the interconnectivity of these two concepts which are in fact also understood in modern physics to be dimensions of the same single phenomenon (Minkowski 1923[1908]). During the past century, ethnographers have documented a fascinating variation in cultural perceptions of time, and the significance of such perceptions and constructions to the discipline of anthropology itself were discussed by Fabian (2002[1983]). Although the literature on time in anthropology is vast, beginning with Evans-Pritchard's classic ethnography on the Nuer and their structural versus ecological time, it seems many ethnographers have found two kinds of time in the cultures they have studied, and as Gould (1987) has argued, these two metaphors, of time's arrow and time's cycle, are also fundamental to Western thinking. In social theory however, these binaries, often simplified as cyclical versus linear time, or social versus sidereal or astronomical "clock" time (Sorokin and Merton 1937) have often been "displaced onto the relation between our society and the rest of the world" (Ingold 1995:27). In his now classic book *The Entropy Law and the Economic Process*, Georgescu-Roegen (1999[1971]:136), essentially made the point that the lack of adequate understanding and analytical separation in economic science between these two kinds of time, thermodynamics and mechanics, Time and time, is at the root of the current ecological crisis.[11] In

[11] This should not be taken to suggest that there are actually two kinds of time. In Georgescu-Roegen's words, time [mechanics] is simply a measure of Time [thermodynamics]. Although it is possible to make an analytical distinction between the physical phenomenon of time and our measures of this phenomenon, the duality of time should be rejected because "[o]bviously, the duality of Time is nonsense. Time moves only forward, and all phenomena take place in the same unique Time" (Georgescu-Roegen 1999[1971]:135).

other words, the inevitable discrepancy between the physical thermodynamic phenomenon of Time, and the way in which this phenomenon is perceived, constructed, measured, and divided by humans is of crucial relevance to the constitution of human economies and how time and space are distributed between people.

Although it has been often reiterated that Andean perception of time and history varied from Western ones as did the concept of *pacha*, native Quechua speakers even had terms to denote time intervals analytically separate from space. In the Huarochirí manuscript, Dedenbach-Salazar Sáenz (2006:21), finds other temporal words, referring to longer or shorter periods of time without implying a spatial component, for instance *mit'a* which is used in connection with numbers (for example "three times"). *Mit'a* of course, was also the term for the Inka labor tax obligation, and this etymological connection highlights how the control of labor requires controlling time, something which can be achieved through symbolic cognitive artifacts, calendars for instance, which support "symbolic and conceptual processes in abstract domains" (Sinha et al. 2011:8). Time reckoning has been linked with "civilization" or complex society, particularly calendar systems charting the movements of the sun (Aveni 2002), precisely because "organizing populations into a larger hierarchy, such as a regional polity of state, requires a standardized measure of time" (Benitez 2009:51). Stellar calendars have also been widely reported in the Andes, and they may serve to structure agrarian and other local activities, for example the arrival of a certain star on the night sky will signal that it is time for sowing and so on. But since stellar constellations vary over geographical distance, they cannot function to organize a geographically dispersed rural population in the same way as solar calendars can. State calendars are therefore almost invariably solar calendars (Aveni 2002).

The Inka state calendar, the *zeq'e* system, which was a powerful instrument for reckoning time (Zuidema 1982:83), and which effectively coordinated all state activity in the Empire will be further described in section four. The roots of this highly sophisticated and monumental time-reckoning system extend deep into Andean cultural history. Along the coast of Peru several structures

---

While Georgescu-Roegen discusses the implications and consequences of time perceptions from an economic perspective, Fabian (2002[1983]:xli) is making a similar argument about their political implications and consequences and stressing that the "radical contemporaneity of mankind is a project" which anthropologists should actively engage in.

with systematic celestial orientations have been identified (Aveni 1992:57). One of these sites, the so-called thirteen towers of Chankillo, has been interpreted as evidence of the existence of a sophisticated solar cult preceding the Inka by more than two millennia (Ghezzi 2008; Ghezzi and Ruggles 2007). The more immediate predecessors of the Inka solar calendar were the Tiwanaku and Wari state calendars (Benitez 2009; Zuidema 2009). As expansive economies and multiregional polities, the Wari, Tiwanaku and Inka empires would all have required "a unified temporal structure within which to organize ritual, agricultural, and civic life" (Benitez 2009:58).

Moreover, when discussing Andean calendars and time reckoning systems it is hard not to evoke the analogical images of weaving (Benitez 2009:71), and of *khipu* strings (Zuidema 1982:71). It is not unreasonable to suggest that the strings constituting the loom were some of the first artifacts which supported cognitive schemas of abstract time-reckoning.[12] They may also have promoted other mathematical exercises, eventually elaborated in the *khipu* reckoning system – the technology which allowed for the ultimate reduction of Inka subjects into abstract units of labor.

[12] For interesting and evocative perspectives on weaving, and the making of string in the history of human society see Barber (1995) and Ingold (2010).

4. Tawantinsuyu, the Inka Empire

Tawantinsuyu, which is today most often referred to as the Inka Empire, was the largest political formation ever to emerge in the prehispanic Americas, stretching more than 4,000 kilometers from modern day Chile and Argentina in the south to Colombia in the north, encompassing most of modern-day Peru, Bolivia, and Ecuador, an area of around two million square kilometers and with a population of at least 10 million people (Wachtel 1977:90; Denevan 1992; D'Altroy 2002:xiii). When Francisco Pizarro and his Spanish conquistadores landed on the Peruvian coast, and ventured on into the Andean highlands in 1532, they were entering an empire which had just been ravaged by civil war between the brothers Waskar and Atawalpa, both sons of the deceased Inka ruler Wayna Qhapaq, and both claiming the title of *Sapa Inka*[13] after their father. Wayna Qhapaq had died in 1527, probably of smallpox reaching the Andes before its original human hosts. The army of Atawalpa, whose stronghold was in the northern part of the Empire, in the Quito area of modern-day Ecuador, had recently defeated Waskar's army, and Waskar was held captive in Cuzco. In November 1532 Atawalpa with all his entourage of perhaps some 80,000 people or more was on his way in royal procession to Cuzco, when he received intelligence of the less than 200 conquistadores approaching. Atawalpa waited to receive the intruders in Cajamarca. This encounter is often described as marking the end of the Inka Empire and the beginning of the colonial era, as it turned out in favor of the conquistadores, who captured Atawalpa, held him captive for almost a year, and finally executed him in late July or August 1533.

One of the most fundamental questions in the field of Inka studies has been the history and expansion of the Empire. Historical information was recorded by the chroniclers, and this information was used by John Rowe to recreate the historical trajectory of the Inka state and ruling dynasty. Rowe's chronology continues to be commonly accepted, but has also continually

---

[13] *Sapa Inka* in Quechua means "Only" or "Unique" Inka.

been questioned and challenged (e.g. Covey 2003; Wedin 1963). One of the main criticism related to the Andean conception of time, has been that Inka understandings of history varied from Western ones, in the sense that the Inka did not have a linear sequential understanding of time and history, and that Inka historical accounts should therefore be read as myth rather than history in the Western sense of the word (Zuidema 1964; cf. Julien 2000). Until quite recently the debate on Inka history and imperial expansion was based almost solely on the interpretation of historical sources as very few archaeological investigations had been carried out in the Inka heartland in the Cuzco area. More recent archaeological research may not solve the issue of dynastic sequence, but it has shed new light on the historical development of the Inka state which probably began centuries before the imperial expansion period that is associated with Pachakuti Inka around 1438 (Bauer and Smit 2015).

Table 4.1
Inka royal dynasty.

Dynasty	Inka ruler	Coya	Estimated span of reign	Chronological Period
Thirteenth Sapa Inka	Atawalpa		1532-1533	Late Horizon
Twelfth Sapa Inka	Waskar	Chuquillanto Coya	1525 - 1532	
Eleventh Sapa Inka	Wayna Qhapaq	Rava Ocllo Coya	1493-1525/27	
Tenth Sapa Inka	Tupa Inka Yupanki	Mama Ocllo Coya	1471-1493	
Ninth Sapa Inka	Pachakuti Inka Yupanki	Mama Anahuarque Coya	1438-1471	
Eight Sapa Inka	Wiraqocha Inka	Mama Yunto Cayan Coya	- 1438	Late Intermediate Period

Based on D'Altroy (2002:37), Shimada (2015:5) and Guaman Poma (1980 [1614]).

At the apex of the political and symbolic hierarchy of the Inka Empire were the *Sapa Inka* and the *Coya*, ideally the Inka's sister by both mother and father, whom he married upon taking office as Inka ruler (D'Altroy 2002:91). Spanish chronicler Garcilaso de la Vega[14] wrote that the Inka and Coya were

[14] Garcilaso de la Vega (1966[1609]), who left Peru in 1560 and wrote his chronicles in Europe, was the son of a Spanish soldier and an Inka princess (J. Rowe 1946:196).

matching honorifics as were their respective titles of *Huacca Khoyaq* (Lover and Benefactor of the Poor), and *Mamancik* (Our Mother) (D'Altroy 2002:91). Even after their death, the mummies of deceased Inka and Coya were revered. Unfortunately women's role and social and political status in the Inka Empire is not well understood since the chroniclers had little interest or possibilities in reporting them, but gender dynamics were unquestionably of great importance in the constitution of Inka and Andean society in general (Silverblatt 1978, 1987). The Inca elite was further divided into a number of categories, of *hanan* and *hurin*, upper and lower, and in Inka-by-blood and Inka-by-privilege.

Colonialism wrecked indigenous Andean society. War, disease, persecution, and the havoc of the colonial encounter led to a decimation of the population. The first written historical sources of the Inka Empire are the accounts by the foreign colonizers who were often soldiers or priests. From their accounts we know that they were both awed and amazed at what they encountered. For instance, Pedro Sancho de La Hoz, the secretary of Francisco Pizarro, compared many features of Inka civilization favorably to that of the Old World. He marveled at the architecture, the terraced landscapes, and the imperial infrastructure in general. The invaders found a well-organized empire, connected by the magnificent Qhapaq Ñan, the stone-paved royal Inka highway, along which were royal *tampu*, way-stations to accommodate travelers and the army, and numerous *qollqa*, storehouses filled with enormous amounts of goods, from staple foodstuffs and textiles to army equipment and bird feathers. The goods stored and accumulated in the *qollqa* came from the Inka provinces and were managed and used by the Inka administration to serve state needs. Even decades after the invasion the *qollqa* continued to feed the new colonial lords and their armies.

Most modern accounts of the Inka Empire begin by remarking that the Inka within a remarkably short period of time managed to build a civilization without such "innovations" as a written language, iron tools, markets, and money - technologies that are often considered fundamental to Old World civilizations and empires. But evidently the Inka had equally efficient technologies for controlling, managing, and directing material and energy flows in their empire.

4.1 Reading the Inka landscape

When Andeans looked toward the horizon they were not, as Europeans generally do, looking into the future. For Andean people, the past was what was visible and ahead of them while the future was invisible and thus behind them (Miracle and Yapita 1981; Bengtsson 1998b). In other respects, also, Andean perceptions of the landscape differed radically from those of Pizarro and his conquistadores, and these fundamentally different ways of seeing the landscape are still today causing conflicts, often violent, in the Andean region. It did not appear to the invaders until almost a century after the invasion just how different indigenous views of the landscape were from their own, when the so-called extirpators of the seventeenth century, who were responsible for rooting out Andean religion or devil worship, as they saw it, began studying and unveiling the ritual and religious beliefs and practices of the native Andeans (e.g. MacCormack 1991). Ever since then, a long tradition in Andean scholarship has tried to reconstruct and map what is often referred to as the sacred landscape of the Inka.

One of the most notorious extirpator of idolatries, Jesuit priest Pablo José de Arriaga, thought that "idolatrous ritual persisted because there were constant physical reminders of obligations to ancestral presence" (Lau 2008:1030). These physical reminders of obligation included idols, mummy bundles, spirit figures, musical instruments, and maize beer and were all "incitements of idolatry" (ibid.). The extirpators also soon discovered that the gods and deities of the Andeans dwelt not only in a wide variety of objects, which the extirpators could locate and destroy, but even in the landscape.[15] They could, for instance, reside in springs, rocks, lakes, and mountains. These features were referred to as *wak'a*, a term which has been translated into "extraordinary and sacred" (Staller 2008:269).

The gods and deities dwelling in the Andean landscape were the creator gods and ancestors of those that temporarily inhabited the living world, and they were highly venerated. One expression of ancestor veneration were the

---

[15] It has been suggested that the tendency of the *wak*'a to dwell in the landscape, in mountains for instance, was a result of the persecution by the extirpators, and therefore to some degree a result of colonialism (Gose 2006). The politico-magical aspects of the Andean landscape can however be traced far back in time (e.g. Kolata and Sangines 1992; Glowacki and Malpass 2003).

mummified royal bodies which were vital in the ritual and political life of Inka Cuzco. The mummies were consulted for advice, which they gave, and were treated in many ways as living persons: they were fed, clothed, carried in procession, etc. (Kaulicke 2001). Other objects and features which were considered *wak'a* were similarly thought of as "persons." As Tamara Bray (2012:201) has stressed, person or personhood in this case should not be understood in the familiar sense of western individualism, but rather in a relational sense (cf. Viveiros de Castro 1998). *Wak'a* and other objects of veneration were often bestowed with gender associations (Staller and Stross 2013:22) and shared kin relations with members of the communities they were associated with. They could also be named, have personal biographies, speak and hear, and were dressed and fed (Bray 2012:200-201).

Wak'a were thus persons in the sense that they mediated social relations. In that capacity, effigies and other objects of veneration enabled physical interaction between human and non-human nature (Lau 2008:1029) through ritual commensality. The landscape and the ancestor deities which dwelled in it fed the people and in return the people fed the ancestors, through libations, sacrifice, offerings, and ritual. What lay behind these activities was the knowledge that the ancestor deities were the source of fertility, abundance and well-being. This exchange is often in the literature framed in the language of gift-giving, drawing on the classic anthropological works on gift-giving and reciprocity. People make gifts, in the form of libations and sacrifices, or by pouring *chicha* through themselves, to "engender and promote a commitment on the part of the mountains, ancestors and other animate forces to the people making the offerings" (Sillar 2009:368).

The Inka and other Andean peoples believed that an animated essence, sometimes referred to as *kamay* (Salomon and Urioste 1991; Bray 2009a; Taylor 2000) or *sami* (Allen 1998; Arnold and Hastorf 2008) permeated all things (Allen 2002[1988]; Flores Ochoa 1977b). Therefore, all life as well as all landscape features, caves, mountains, and lagoons that together constituted *pacha* were sacred to some degree (Staller and Stross 2013:22). The function of ritual and sacrifice was to "ensure a steady circulation of biological energy, through *pacha*, by conducting social exchange among its living parts" (Salomon and Urioste 1991:16). This principle of reciprocity applied not only to the agricultural sphere but also to other substances such as metals, which "grew" in the mountains like tubers and potatoes grew in the fields (Harris 1989). As put by Urton (1997:211) "[t]he ancient Andean

world was integrated by a well-articulated body of philosophical principles and values that were a continuous attempt to maintain balance, harmony, and equilibrium in the material, social, and moral spheres of community life."

4.1.1 Ritual commensality

The social relationship between humans and things or landscapes is most forcefully expressed through commensal rituals and mutual consumption; only if people give nourishment to the earth can they expect to be fed in return (Isbell 1985[1978]; Weismantel 1988; Gose 1994; Sillar 2000a). This is what Ramírez (2005:150) has referred to as a reciprocal relationship, which can be summarized as "to feed and be fed." Since the landscape provided people with food, stone, metals, water, and everything else which humans rely upon for their subsistence, something had to be given back. On certain occasions, the ultimate sacrifice of humans was required to satisfy the appetite of the deities.

The "mutuality" between humans and landscape, the secular and the supernatural, is expressed in a number of ways among contemporary Andeans (Sillar 2009:368-70), and similar conceptions were described by Cobo (1990:115-117). Food offerings can be sent through the body of a participant who consumes food and drink in the place of an ancestor or a deity. *Chicha* often plays a pivotal role in such practices, and it was a central technique to communicate with the gods in prehispanic times (Ramírez 2005:145). Another form of expression are the frequent libations, for example pouring *chicha* on the ground before drinking, or blowing *sami,* the essential essence of the coca leaf, toward the recipient, which might for instance be a mountain. Finally, offerings and sacrifices may be burnt or buried.

Each of these methods of expressing the mutual relationship between people and landscape demands the preparation of different goods (Sillar 2009:370). The sacrifice of exotic items such as *Spondylus* shell (*mullu*), which originated in the warmer waters along the Ecuadorian coast, described in the Huarochirí manuscript as "food for the gods," could only be obtained through long-distance trade or exchange, and coca leaf likewise had to be imported to the highland. It is clear that some of these practices leave more traces in the landscape than others. Blowing the *sami* of coca leafs leaves no immediate archaeological trace. However, the cultural significance and demand for coca

might dramatically alter landscapes and livelihoods in areas very far from where its essence is blown, which was indeed the case in the Inka Empire (e.g. Murra 1980; D'Altroy 2015). All of these methods leave traces in the landscape which are increasingly being recognized by archaeologists. Large quantities of cooking and serving jars, piles of disarticulated camelid bones, metal pieces and *Spondylus* shells in the vicinity of distinct landscape features might indicate these places could be interpreted as potential *wak'a* (Bray 2012). The intention behind these activities manifested in the landscape, argues Bray (2012:202), was to include the *wak'a* in the act of food sharing, thus recognizing its personhood and forging or reaffirming its relationship to the local community.

Ramírez (2005) has argued that it was this very social relation between the supernatural and the secular realm which was at the foundation of power in the Andean world. The elites achieved their elevated status in Andean society through their roles as the human intermediaries responsible for maintaining the balance and reciprocity between these two realms, by sponsoring feasts and enacting the rituals of reciprocity. The elites were entrusted with the task of securing the welfare of both the living and the dead, both those of the secular world and the ancestors in the supernatural realm (Ramírez 2005:150). They did this by assuring the continued flow of energy, mediating between humanity and the supernatural, and thereby maintained the equilibrium of the universe (Saignes 1987; Ramírez 2005:135). The native elites, the *kuraka*, were therefore in a position to apportion a part of their subjects' labor for offerings and ritual expenses which were to satisfy the appetite of the gods (Ramírez 2005:150), and this constructed belief legitimized traditional authority and the exercise of power (ibid., 146). Celebrating and worshipping at the graves of the ancestors or some other *wak'a*, drinking the lord's *chicha* and eating from the carcasses of sacrificial animal, often camelids, reenacted and reinforced ethnic solidarity as well as the communal hierarchies (ibid.). Such practices of special public ceremonies combining feasting and ancestor veneration to legitimize authority and unequal access to goods and labor long predate the Inka (Lau 2002).

As tends to be the case with power, this relationship worked as a matter of tautology. Those who were powerful necessarily had the favor of the ancestors, otherwise they would not have been powerful. If, on the other hand, community was struck by misfortune, failed harvests, droughts, or war,

the situation could quickly turn, since it could be interpreted as a sign of supernatural discontent with extant human leadership.

Understanding Inka power from an emic perspective thus requires an understanding of how the Inka coopted the already existing hierarchical relations and accepted asymmetries, to control the material flows which originated from them, so that Inka subjects in many instances were more or less doing what they had been doing previous to conquest, only their products were now appropriated by a different elite. The Inka administration is also known to have adapted their administrative strategies to local circumstances. Sometimes changes were abrupt and dramatic, at other times slow and covert.

This background illustrates that the Inka relationship with the landscape was complex. The Inka referred to landscape features around Cuzco in terms of kinship and body parts (van de Guchte 1999), indicating a personalized relationship, and Inka architecture was often incorporated into landscapes, accentuating already existing natural features, rather than imposed on them. But landscape could be both benevolent and dangerous. It was not only conquered peoples who needed to be subjugated, their landscapes also had to be domesticated, and Inka architecture including the extensive terracing projects initiated by the Inka state in the provinces should be seen in this light; terracing was as much a form of symbolic domination as it was a way of increasing the production of maize. The Inka practice of making offerings, sometimes human, for instance on important mountains (Wilson et al. 2007), can be seen as an Inka strategy to "physically claim sacred sites and spaces" (Bray 2009a), but it can also be seen as an act of "communication with the sentient power of these places" (Sillar 2009:374). Rather than understanding these two perspectives as mutually exclusive, the fact that they are simultaneous is essential to understanding their effectiveness. Like the Inka rulers, local *kuraka* often sacrificed llamas "to please the ancestors in return for power" (Ramírez 2005:146). The importance of sacrifice in the Inka Empire - the enormous quantities of cloth, camelids, and other offerings which were consumed in frequent ritual sacrificial fires - must be understood in this context.

4.1.2 The *zeq'e* system

To control and domesticate this sacred landscape, the Inka organized it into the so-called *zeq'e* system. One of the most intriguing aspects of Inka society, the *zeq'e* system was the imperial solar calendar which was embedded in the landscape surrounding Cuzco, and in relation to which all daily activities in Cuzco were organized (Zuidema 1964).[16] It consisted of 41 (or 42) imaginary lines which radiated out from the central plaza or the Qorikancha in Cuzco. This system was both a religious map and a calendar, and also an abstract representation of Inka socio-political structure and order (Shimada 2015:11). Along the *zeq'e* lines were between 328 and 350 *wak'a*, each of which received sacrificial offerings on a particular day of the year (Urton 2015:152). The function of calendars in controlling time and space has already been dealt with and Urton writes that what made this ritual/calendrical *zeq'e* system political was that specific *ayllu* or *panaqa*[17] were responsible for sacrificial offerings at the *wak'a* assigned to them, and specific sectors of the terrain in and around the city as well as specific segments of time in the calendar, were related to one or another of the *panaqa* and *ayllu* that Cuzco was divided into (Urton 2015:152). Social and political inequality was thus encoded into the landscape. The chroniclers write about a number of pillars in Cuzco, which served as sun dials to demarcate the temporal sequence of imperial affairs, planting times, communal labor work, and everything else which the state wanted to control. Garcilaso wrote that a similar set of pillars were erected in Quito to standardize time in the northern half of the empire (Aveni 1992:57), and Stanish (2010, 2012) has found evidence of similar pillars at Tiwanaku, erected to serve as ritual spaces, organizing social hierarchies through solar alignments, which suggests that this was a strategy used throughout the Empire.

The Inka calendar has been reconstructed from the information given by the chroniclers and was divided into a 12-month year (Bauer and Dearborn 1995: Table 2; D'Altroy 2002:152-153). Zuidema has argued that the year was further divided into 41 weeks of 8 days, the number 41 corresponding to the 41 *zeq'e* lines, and multiplied by 8, corresponding to the days in the week,

[16] For a thorough description and overview of the many organizational aspects of the Inka calendar or *zeq'e* system, see Yaya (2012).

[17] *Panaqa* was the term for the Inka royal *ayllu* or lineages of Cuzco.

thus comprising the 328 *wak'a* in the *zeq'e* system. The remaining days of the 365-day annual cycle were periods of rest (Urton 2015:152).

Keeping track of the *zeq'e* system - carrying out all appropriate rituals and sacrificial offerings - required enormous effort, and information from the chroniclers suggests that similar ritual/calendrical systems in all Inka provinces were maintained on the instructions and orders of the Inka (Zuidema 1982:79). Cobo moreover wrote that the *zeq'e* system was so complex that it required over a thousand men in Cuzco who "did nothing but remember these things," that is, memorize the location and powers of the *wak'a*, what prayers and sacrifices should be made to each of them, and so on (Cobo 1990[1653]:9). Through their labor these *kamayuq* of the zeq'e system were materializing an ideology and an empire just as much as the people who produced the more tangible artifacts or craft items.

4.1.3 Complementarity and dual organization

According to the generally accepted model of central Andean political economy, the so-called vertical archipelago, first proposed by Murra (1972), and also known as verticality or (zonal) complementarity, the *ayllu* kingroup was the organizing economic unit of central Andean life. *Ayllu* were largely self-sufficient economic units, and through belonging to an *ayllu*, which held its productive resources in common, people had access to land and other necessities. Access to resources in different eco-zones was secured through direct control of those lands rather than through trade or exchange. While the population was concentrated in the *altiplano* zone, members of the *ayllu* occupied other zones or "islands" and maintained rights as *ayllu* members even if not residing there. Membership was defined through kinship and these ties were regularly reaffirmed ceremonially. The resources produced in the various eco-zones or "islands" under the control of the *ayllu* were distributed among *ayllu* members through reciprocity and redistribution (Murra 1985). *Ayllu* are sometimes described as corporate kin groups led by *kuraka.* As already mentioned, *kuraka* enjoyed certain privileges such as greater access to different ecological zones, rights to get their lands worked by other members of the *ayllu*, as well as craft items (Murra 1980). In return, *kuraka* and the *ayllu* elites were to provide certain services, such as military and ritual leadership, *chicha*, and coca leaf. Since the *kuraka* often controlled the coca fields, they were in a privileged position to distribute it to *ayllu*

members. Often such distribution was carried out at feasts sponsored by the *kuraka*, which served to consolidate the groups, but also to regularly reinforce inequality (D'Altroy 2015:101-102).

Labor exchange was likewise organized through kinship ties within the *ayllu*. The terms and moral principles guiding such exchange have already been mentioned, a*yni* implying symmetrical labor exchange between *ayllu* members of equal status. In modern times at least, *ayni* implies strict record keeping, a favor must be precisely reciprocated (Allen 2002[1988]:72), and many observers have reported almost obsessive record keeping with these favors owed in Andean communities (Allen 2002[1988]) a "behavior consistent with *khipu* record keeping" (Mayer 2002:129). *Mink'a* organized communal labor, which was not reciprocated with an equal share of labor in return, but with food and drink. While *ayni* implied exchange between parties of equal status, *mink'a* implied an unequal relation, where the person working for food and drink was accepting an inferior position to the person sponsoring the work with food and drink.

The Inka state and administration are said to have coopted these *ayllu*-based forms of reciprocal exchange and expanded them on an imperial scale. The logic of such imperial reciprocity worked through conquest so that when the Inka state conquered and/or annexed new territory it claimed all resources in that area. Through a "pact of reciprocity" *ayllu* members had to work as tributaries in order to get access to land, herds, and also, for instance, the right to marry (Gose 2000:85). Gose (ibid.,86) therefore suggests that the idiom of *mink'a* is more appropriate to describe economic relations in the Andes, as *mink'a* specifically implies that a labor service is exchanged for goods, food, and drink. Gose argues further that the existence of the notion and principle of *mink'a*, well established in *ayllu* organization prior to Inka conquest, was the main reason why the Inka state insisted on feeding its tributaries. Since being fed in return for work implied an inferior position, the state needed to mask the fact that the tributaries were of course feeding the Inka state through their labor efforts.

These principles guiding economic exchange were also expressed ritually; one important expression was the serving and drinking of *chicha*. Allen (2002[1988]:121) describes drinking etiquette in the Andes as hierarchical and asymmetrical and consistent with the concept of *mink'a*. In contrast, *hallpay* etiquette (that is the sharing of coca leaf) evokes the principle of *ayni*. A person receiving and accepting a drink is implicitly accepting to owe

the server of the drink a favor, and the sacred connotations of *chicha*, or other alcoholic beverages, moreover give this debt a strong moral character. The only way to reciprocate is to accept a request made by the person serving the drink.

The complete negation of trade and markets in Murra's original model of complementarity or "vertical archipelago" has since been questioned, and alternative models have been proposed and documented in other regions of the Andes incorporated into the Inka Empire (Rostworowski 1999; Salomon 1986; Hornborg 2014; Stanish 2003:69-70). Stanish (1992:15) has argued that Murra, influenced by the substantivist view of economy proposed by Polanyi, was explicit about excluding exchange processes, in part because he perceived "a structural linkage between exchange and markets" (1992:15). Likewise the perception that money was "never invented" by the Inka has often been reiterated, but although the Inka did not adopt money into their imperial economy, there were at least three kinds of special purpose money circulating within the borders of the Inka Empire: in the Chincha Valley and in Huancavelica in central Peru as well as on the north coast of Peru (Santillana 2008; Espinoza 2008; D'Altroy 2015:115 note 2).

In summary, it is generally accepted that the basic mechanisms through which the Inka elite dominated the local communities or *ayllu* they conquered were already in place, and that the Inka state simply manipulated these moral principles to their own advantage. Murra has shown that even before the Inka's arrival each community reserved part of its common lands for the maize cultivation or llama breeding required by the cult of their ancestors and gods, and another part for the needs of their chiefs, the poor, the orphans, and so on. It was on this basis that the Inka system of exploitation was built (Murra 1980; Godelier 1986:103).

A common understanding of Andean and Inka society is that the principle of dualism, as a form of cultural logic or "fundamental tenet of native Andean cosmology" (Sallnow 1987:217), was the underlying cultural principle structuring social and political organization in the Inka Empire at all levels of society. Tawantinsuyu, the term the Inka used to designate their empire, meant "the four parts together," denoting that the empire was divided into four parts or *suyu*, which were again grouped together into two halves or *saya,* but each part or half always being hierarchically related to the other. All *ayllu* and *panaqa* were also divided into *hanan* and *hurin*, meaning "upper" and "lower" respectively. These divisions also evoke the principle of

complementarity, as the two complementary halves were required to constitute a whole. Such complementarity or dualism has been observed and described in gender relations between the sexes, in the relations between the ecological zones, in Inka decimal administration, and so on (Pozo 2002; Platt 1986; Harris 1986; Isbell 1985[1978]).

Andean dualism denotes hierarchy, a relation evoked through the concept of *yanantin*. The term *yanantin* is made up of the term *yana* “help” and -*ntin* which means “inclusive in nature, with implications of totality, spatial inclusion of one thing into another, or identification of two elements as members of the same category” or simply “helper and helped united to form one category” (Pozo 2002:12). *Yanantin* can also be expressed as two sides or an (un)equal pair, such as body parts, for example eyes or hands, or husband and wife. In their structural analyses of traditional Andean communities, Platt (1986), Harris (1986), and Bouysse-Cassagne (1986) demonstrate how dualism was related to the inevitable asymmetry of human relationships. Platt (1986:256-7) argues that the analysis of *yanantin* suggests a:

> mechanism that represents as symmetrical and equal a relationship that in fact lacks that symmetry. Thus the inequality between man and woman, crystalized in the male monopoly of political power, is presented as a purely logical problem for which logico-symbolic treatment alone is appropriate. In this case, the growth of exploitation beneath a mask of reciprocity under the great Andean states and kingdoms is to be seen as an aggravation, a projection onto the emergent class societies, of an antagonism already present in the heart of the preexisting Andean communities, at the very center of the productive process: within the household.

In the ongoing debate over whether Andean cosmological principles are based on hierarchy or on egalitarianism (Murra 1970; Schaedel 1988; Gelles 1995), the simple answer is that they are both.

4.1.4 The Inka tribute and administrative system

Controlling a large labor force was the most crucial element of the Inka imperial economy, and the Inka administrative system, the so-called decimal administration, was largely geared to organizing the tax paying population in order to facilitate tax exaction. As a political and military power, Inka

imperial metabolism required enormous quantities of staples, crafts, and goods of all kinds, and virtually everything can be assumed to have been appropriated from Inka subjects one way or another. The Inka state asserted that it exacted tribute only in labor, never in kind (Murra 1980). The reason for the Inka insistence on this symbolic framing was probably that it resonated with the notion of *mink'a,* which facilitated and legitimized this kind of economic exchange in the Andes.

In the ideal "reciprocal" model of the relations between the Inka state, personified in the *Sapa* Inka (Pärssinen 2015), and conquered subject groups, a certain portion of the annexed land was re-allotted to the group, which would be responsible for its own subsistence. In return, each household listed on the *khipu* census would be obliged to perform labor service (*mit'a*) on a rotating basis for a certain period of time (two or three months is commonly stated, but this would undoubtedly have varied according to circumstances). While performing labor for the Inka state, the workers would be supported by the state with food and drink.

The tax-paying unit was the household, headed by the husband who received the title of *hatun runa* upon marriage, and comprising his wife and children. The tax demand on every household was not calibrated to how many members the household consisted of, and having more children is sometimes mentioned as a strategy to alleviate the pressure of the tax obligation, as families could distribute part of the labor demand to their unmarried children. The list of tax obligations numbered up to 40 different kinds of labor service. In addition to these came the military and agricultural labor service, which according to D'Altroy (2015:102) probably made up the largest share. The taxation strategies of the Inka state aimed at the households can be tentatively divided into three groupings. The first consisted of tending to state agricultural lands and camelid herds. The second was a household tax which could be the production of crafts and the collection of other goods desired by the state such as bird feathers or honey (D'Altroy 2002:290). A specific part of this obligation, sometimes labeled the textile tax, demanded that every household was required to produce (at least) one tunic for the state every year. It was specifically asserted that the fleece for such household production was provided from state holdings, not the herds owned by the community. The third main strategy was the *mit'a,* the rotational labor service which could entail everything from military service, postal service, or personal service for the nobles to mining and public works, such as road or

wall construction (J. Rowe 1946:267-8). Regular records and assessments of labor personnel and local resources were compared to state needs and wants, and annual labor obligations were announced every year at state-sponsored festivals (D'Altroy 2015:102).

It was not only the distribution of labor obligations that was announced on festive occasions. Some of the labor obligations were similarly organized as communal feasts, particularly agricultural work. Many external observers have remarked upon the peculiar habit of Andeans to dress in their finest clothes and be conspicuously cheerful when going to work in the fields (J. Rowe 1946; Harris 2007). How old the roots to these traditions are is difficult to say, whether they antedate the Inka or if it was an Inka "innovation," but such arrangements would no doubt have served to lubricate the exaction of this particular kind of labor.

Although it is clear that, in principle at least, the Inka state was responsible for feeding both *mit'a* and agricultural tax labor, very little attention has been paid to how this food and drink was prepared and served, and by whom (Gose 2000). Certainly it was not the Inka elite themselves who carried out this work. Gose (2000) has suggested that the work was carried out by the *aqllakuna*, and that their numbers were much greater than often assumed. Alternatively it could have been members of the households of those who carried out the labor obligation, or a mixture of both.

Another imperial Inka strategy were the *mitmaqkuna* resettlement schemes. It has been suggested that the *mitmaqkuna* colonies were an adaptation of the custom of Inka *ayllu* to control complementary ecological zones through outlying settlements. The policy was reportedly instituted by Inka Pachakuti to reduce local resistance and as punishment for uprisings, but it was also of immense economic importance. D'Altroy (2015:103) writes that by the end of Inka rule, between three and four million people had been relocated as *mitmaqkuna*. *Mitmaqkuna* were forcedly relocated from their home territory, whether to work new lands for the Inka, produce crafts, or man army garrisons at the empire's borders. They retained their status as members of their home community but were also listed in the censuses in their new location in order to keep track of their labor. *Mitmaqkuna* were often sent out as colonizers to displace local people and grow crops such as maize and coca for the state (Bonavia 2000:131). The large state farms set up by Wayna Qhapaq, for instance at Cochabamba in Boliva, were also settled by

mitmaqkuna, as many as 14,000 people from other Inka provinces, while the locals were displaced (Wachtel 1982; La Lone and La Lone 1987).

As the Empire expanded, however, the common taxation system and the *mitmaqkuna* institution were apparently not sufficient. Murra (1980) suggested that the institutionalization of special classes or castes of people developed during the reign of Wayna Qhapaq (D'Altroy 2015:103). These were people who, like the *mitmaqkuna,* were severed from their home communities and relocated, but unlike the *mitmaqkuna* the *yanakuna* lost their status as *ayllu* members and were converted into state retainers on a permanent basis. *Yanakuna* were either individuals or groups of people who were permanently separated from their homeland and kin groups, and they have often been described as slaves (Godelier 1974:65). The *mitmaqkuna* population of Chupachu, who lived in the Alto Huallaga zone in the middle of the Ceja de Selva (Bonavia 2000:126), and who have become well known through the *visita* of Ortiz de Zuñiga, were apparently all turned into *yanakuna* by Waskar shortly before the European invasion turned things on their head (Julien 1993:209). *Yanakuna* were in permanent service to the Inka state and could carry out any duty, such as farming, herding, or household service for the Inka elite (D'Altroy 2015:103).

The *aqllakuna* were girls or women who were taken from their local communities at a young age and placed in *aqllawasi.* The Spanish often referred to the *aqlla* as nuns and *aqllawasi* (house of *aqlla*) as convents, but the main occupation of the *aqlla* was probably to weave fine textiles and brew *chicha* for the Inka state. It is unclear how large the number of *aqlla* was, and quite probably, the number of *aqlla* at any one time probably reflected the need the state had for them, and Gose (2000:87) finds historical evidence that not only the larger ceremonial and administrative centers had *aqllawasi*, as often assumed in the literature, but that even smaller towns had a house of seclusion for women who prepared food and drink. Gose believes that the demographic scope of this social category has been highly underestimated, and that it was the *aqlla* who prepared and served the food and drink for the *mit'a* and other kinds of labor service in the provinces. The institution of *aqllakuna* was thus a way of appropriating female labor, which the state needed to perform its *mink'a* duties towards the tributaries. As Gose (2000) suggests, at least a portion of the *aqllakuna* lost their status as *aqlla* when they were given away in marriage after a period of seclusion in the *aqllawasi*. Those who remained in the service of the state were the

mamakuna or priestesses, who trained the *aqllakuna*, brewed *chicha*, and wove the most valued cloth in the realm (D'Altroy 2002:189,290).

The *kamayuqkuna* (the craft specialists) may be seen as another such category of people, who were in permanent service to the state. Like the *yanakuna* the *kamayuqkuna* were exempt from the agricultural and *mit'a* tax but labored full-time for the Inka state, either for noble Cuzco households or provincial lords, and their status was hereditary. The sources do not agree on how large and inclusive this category was. Some mention that there were only three or four categories of *kamayuqkuna* (Cobo 1990[1653]:240; Dean 2010:113),[18] while others state that *kamayuqkuna* could be miners, herders, stone workers, carpenters, weavers of fine textiles, sandal makers, potters, goldsmiths, and so on (Kolata 2013:87). Like the *mitmaqkuna* they are said to have supported themselves on land given to them by the Inka state or by exchanging their craft products for food (ibid.).

4.1.5 *Khipu* – Inka accounting technology

The Spanish soldier and chronicler Pedro Cieza de León claimed that the Inka administration held such strict account of the goods collected in tribute that in their entire kingdom not even a "pair of sandals" would go unaccounted for (Cieza 1967[1551]:36; Kolata 2013). Considering the large scale of the empire, both in area and population, accounting would of course require the ability to deal with such quantities numerically. The device with which such accounting was made possible was the *khipu. Khipu* recording was the primary technique used by the Inka to store numeral information, and perhaps even historical information could be recorded in the *khipu*. *Khipu* were strings made of cotton or wool, or both, and information could be coded in them through knots, color, sequence, and the direction of twining. Garcilaso wrote that:

> when the Inca had conquered a province he had a record made on his *knots and beads* … of the pasture lands, high and low hills, ploughlands, estates, mines of metals, saltworks, springs, lakes, and rivers, cotton fields, and wild fruit trees, and flocks of both kinds, including those that produced wool and those that did not. All these things and many others he had counted, and

[18] Cobo (1990:240) writes that the categories of *kamayuq* were *qompi* weavers, stonemasons and silversmiths.

recorded under separate headings, firstly the totals for the whole province, and then those for each village and each inhabitant. They measured the length and breadth of the arable land. When all details were known a full report was made of the whole province" (Garcilaso quoted in Urton 2010:56, emphasis in original).

Garcilaso also stated that the *khipu* could hold information about the amount of labor carried out by each tribute payer.

> [T]he knots showed how much work each Indian had done, what crafts he had worked at, what journeys he had made on the instructions of his ruler or his superiors, and any other occupation he had busied himself with; all this was deducted from the tribute he was required to produce (Garcilaso quoted in Urton 2010:60).

Although we cannot be certain of their reliability, these accounts indicate that the Inka administration kept debit/credit records of the tribute obligations of every individual tribute subject. A quote from Cobo provides information on how tributaries were accounted for:

> in order to find out the number of people that there were in each province, including both the natives and the *mitimaes* [*mitmaqkuna*], nobles and plebians, it was ordered that everyone be counted according to age, social position, and marital status; special lists were made of the taxpayers and of those who were exempt, of children, women, and old people. Within the ranks of the taxpayers were included only males from among the common people who were between twenty-five and fifty years old, more or less, since among them age was not counted in years (Cobo 1979[1653]:194).

Cieza and other Spanish sources stress the wide and complex variety of information efficiently encoded in the Inka *khipu* (Urton 2015:149). As with so many other characteristics of Inka statecraft, the *khipu* were also a technological development inherited from earlier polities, and it is widely believed that *khipu* were used in the Wari administration during the Middle horizon (Schreiber 1992; Urton 2008:836-837). Those responsible for keeping *khipu* accounts were the *khipukamayuq*. In the provinces, the population was divided according to the system of so-called decimal administration into units of 10, 50, 100, 500, 1000, 5000, and up to 10,000 households and labor units (Urton 2015:153). At every level of this system was a leader, and at distinct levels these leading officials and rulers were served by *khipukamayuq*. Each moiety (half of a community), for instance, had head officials (one for the *hanansaya* and one for the *hurinsaya*) who

were served by a pair of *khipukamayuq*. This pair of *khipukamayuq* kept records not only of their own moiety, but also the other, so that at any time there were two copies of the complete community accounting (Urton 2015:159). The *khipukamayuq* were responsible for keeping track of what tasks should be fulfilled in tribute obligation, organized tribute workers into decimal groupings, and recorded information concerning member attendance and participation in the work tasks assigned to groups by the state (Urton 2015:153). The role of the *khipu* and *khipukamayuq* in facilitating the appropriation of labor can hardly be overestimated. To carry the *khipu* and the information they held around in the Empire, *chasqui* runners were stationed at regular intervals along the Inka roads, enabling efficient coordination of the imperial organization of land and populations.

According to sixteenth-century chronicler Martin de Murúa, the education of a *khipukamayuq* took four years. Formal training was received in Cuzco, the first year dedicated to learning the language of the Inka, the second year to learning about the worship of the *wak'a*, the third "the business of good government and authority, and the laws and the obedience they had to have for the Inca and his governors," and last, they learned the histories and deeds of the past (Urton 2015:158).

The knowledge of reading *khipu* was not transferred to Europeans, and their meanings remain obscure. *Khipu* accounting, however, continued in the colonial period (Urton 2015:161) and even into modern times (Salomon 2004). There are around 850 known *khipu* preserved in collections around the world, but only few have been recovered archaeologically, and many have no established provenance (Urton 2015:151). Although the *khipu* once held detailed information about many aspects of the Inka Empire, which archaeologists and others are trying to reconstruct, this information is probably irretrievably lost, as the *khipu*, like other information technology, are meaningful only within their cultural context.

4.1.6 The productive Andean landscape

The productive capacity of the Andean landscape was of course the biophysical foundation of Inka society and culture. The social institutions described above must be considered sophisticated modes of environmental management in an extremely diverse landscape. These institutions were

developed through millennia of human-environmental interaction, and the Inka landscape was a truly cultured one.

The domestication of the Andean highlands began millennia prior to the Inka Empire through a process of co-evolution connecting humans and a wide variety of plant species, mostly grains and tubers, and animals such as the two domesticated camelid species, the llama and the alpaca,[19] all specialized, high-altitude means of harnessing solar energy. These domesticates, together with the improved landscapes, were the "agricultural base of the pre-Incan Andean civilization" (A. Morris 1999; O. Cook 1925).

Apart from the domestication of plants and animals, Andeans increased the productive capacity of land by investing labor in landscape modifications, so-called landesque capital. Landesque capital can be defined as "enduring non-alienable anthropogenic modifications of landscapes that increase physical productivity per unit of space" (Hornborg et al. 2014:216). Landesque capital increases the capture and transformation of solar energy in forms useful or desirable for humans. Such landscape modifications are readily visible in the Andean landscape and some of them, like the agricultural terraces, were immediately recognizable to the Spanish invaders. Other forms of landesque capital such as the raised fields of the Titicaca basin or the adjacent *qochas* have only recently been brought to the attention of researchers. The domestication of the landscape in the Andes was initially a slow and incremental process (Lumbreras 2008:62; Doolittle 1984), but once completed it provided access to significant surpluses.

The first examples of landesque capital in the Andes can be traced far back in time. In the highlands, some of the earliest forms of landesque capital were constructed to control water in the so-called *bofedales*[20] to increase forage for camelids (Lumbreras 2008:63). The first traces of terrace constructions are dated to 2400 BC (Denevan 2001:199) and around AD 600 it seems that the construction of agricultural terraces was an important element of Wari colonial efforts (Schreiber 1992). Raised fields also appear early and large-scale investment seems to begin around 900 BC in the Titicaca Basin. Another form of landesque capital in the highlands are the *qochas* or sunken fields which have been associated with Pukara north of Lake Titicaca around

[19] The domestication of the llama and alpaca is dated to around 4000 BC, and camelid herding to 3500 BC (Bonavia 2008).

[20] *Bofedales* are improved highland pastures. See more below.

200 BC. In the coastal regions, large-scale irrigation systems can be dated back to 1800 BC, and were crucial for the agricultural base of society. The large-scale construction of sunken fields or gardens has been associated with the Chimú state around AD 900 (Hornborg et al. 2014). The Inka were thus heirs to a long tradition of landscape investments, going back millennia, which they appropriated through conquest, along with other infrastructure such as roads, *khipu* technology and more (D'Altroy 2002:41).

The main form of landesque capital associated with the Inka Empire are agricultural terraces. Much like the Wari seem to have done 500 years earlier, the Inka increased the amount of agricultural land suitable for maize cultivation through terracing. Although landesque capital was a form of investment which potentially increased physical productivity, agricultural terraces in the Inka Empire were also symbolic capital (Goodman-Elgar 2009) as they signaled Inka presence and dominance. The Inka envisioned themselves as domesticators of the landscape, and terracing was presented by the Inka elite as a way of reclaiming unused or marginal lands without encroaching on the land used by the local *ayllu*. It is often stated that the Inka primarily intensified production through incorporating "unused" or "underused" lands into production and through manipulation of landforms and water (D'Altroy 2015:108). Historical information indeed suggests that this was the Inka understanding of their imperial project. However, as recent advances in the field of political ecology have demonstrated "unused" or "underused" often simply means that the people who use these lands are "not counted" in the political economies. This was unquestionably also true of the Inka Empire. In her analysis of modern development programs in the Andes designed to increase agricultural output, Paulson (2005) convincingly demonstrates how increased investments in certain landscape features lead to the degradation of other features, as well as to increasing social inequalities. As agricultural systems are also social systems (Hastorf 1993), land use change inevitably implies some degree of change in social and political relations. Hastorf's (1990) studies from the Mantaro Valley documenting increasing social inequalities in subject communities as a result of Inka imperial policies, and Paulson's analysis of the impact of modern development paradigms on Andean landscapes show interesting parallels.

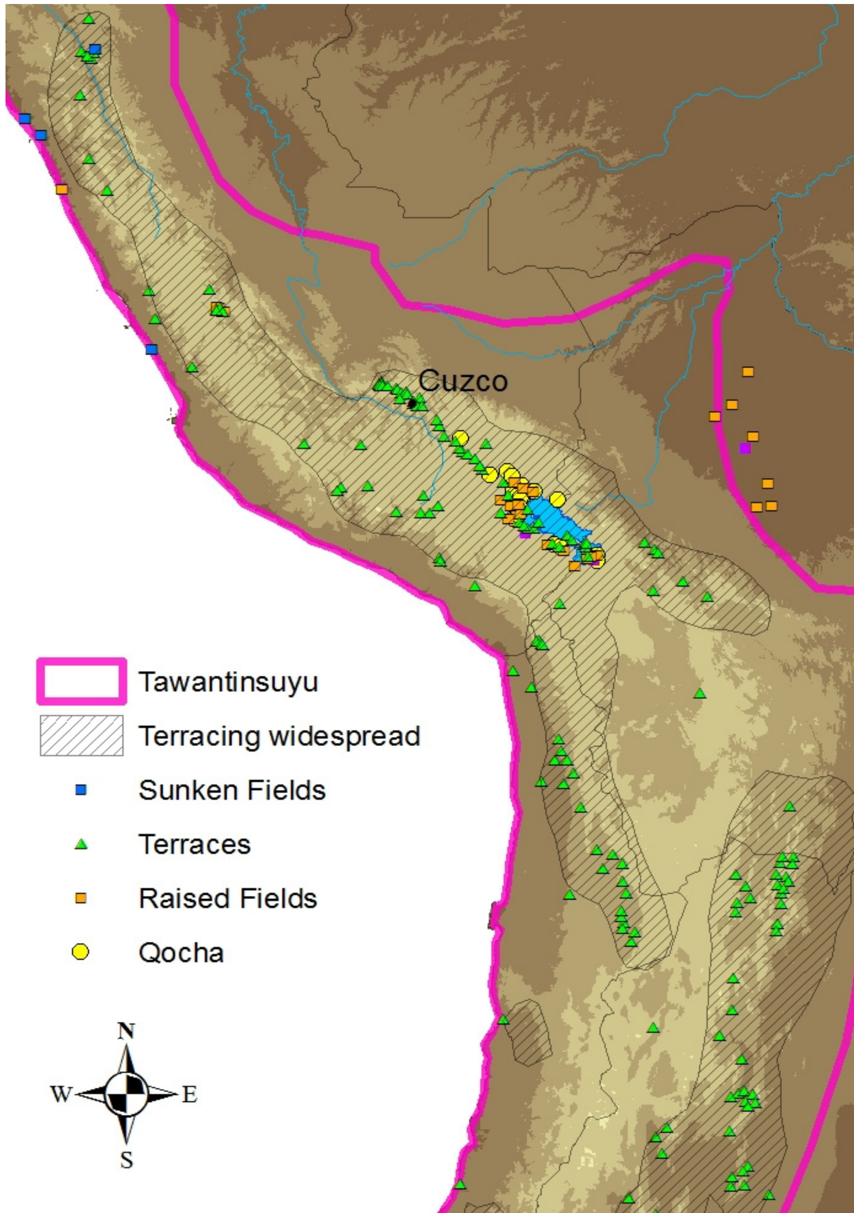

Figure 4.1
Reported sites with landesque capital in the Andes.

4.1.7 Andean land-use zones

It is often stated that the Andean region provides a harsh and challenging environment for people to make a living in. Nevertheless, the Andean landscape was also a thoroughly domesticated and cultured one. Because of the vertical ecology of the Andean region - the steep ascent of the Andean mountain chains from the coast to elevations of 6000 meters and more - land-use strategies in the region are correspondingly varied. This great variation has been classified in a number of ways. One of the most influential models was proposed by Pulgar Vidal (n.d.), who combined native Andean terminology with modern science based classifications, and divided the Andean landscape into eight production zones from the Pacific coast to the Amazonian lowlands. These different models of environmental or ecological production zones have all been criticized, as well as the zonal approach to the Andean landscape in itself (Zimmerer 1999). Particularly the tendency to relate the various production zones to specific ecological or geographical conditions (such as altitude, precipitation, etc.) has been criticized. Mayer (2002:241) has suggested that Andean production zones should not be understood as adaptations to the mountain ecology, but as landscapes created, managed, and maintained by people. Such landscape "creation" can be recognized in the domesticated flora and fauna of the Andes, and in the ubiquity of landscape modifications or landesque capital. Landesque capital, however, serves not only to increase or intensify production; it also to a large extent determines how landscapes are utilized, by whom, and for what. This dual function of landscape modifications is often described in the literature, and helps explain why investing in such forms of capital was a predominant strategy of ancient empires; investing in landesque capital is an effective strategy for controlling energy flows, both human and other forms of energy (and material) flows.

4.1.8 The Andean agropastoral landscape

The Andean highland economy is often described as agro-pastoral, an economic system combining agriculture and herding. Today most camelid herding is conducted above 4000 meters, and agriculture is generally considered to be difficult above 3800 masl (Maldonado Fonkén 2014:7). Land above this elevation is generally considered pasture land, the primary economic significance of which is herding (Erickson 1992; Hastorf 1993).

Nevertheless, it has long been argued that camelid herding was much more widespread during the Inka period, and although there is a tendency to view pasture land and agricultural land as two separate ecological production zones, agriculture is in fact feasible up to around 4,250 masl or even higher; particularly the Andean grains (quinoa and *cañihua*) and certain kinds of potato will yield well and are tolerant to frost (Thomas 1972:48).

The vast expanses of the altiplano, the high *puna*, and the Southern Andean steppe in modern-day Peru, Bolivia, Chile, and Argentina were home to millions of camelids and other wildlife in prehispanic times and the control of this production zone was a major concern of the Inka in the early days of establishing their empire (Rostworowski 1999:68pp). Andean pasture land is often classified into two main categories, which are also used in this study: pampa pasture and *bofedal* pasture. *Bofedales*, or *oconales* (from the Quechua word *ocko* meaning "wet"), are areas of wetland vegetation, and they are important sources of water and vegetation for livestock in the highlands (Maldonado Fonkén 2014). *Bofedales* occur naturally, but can also be enhanced or increased through different forms of water management. Particularly alpacas are dependent upon *bofedal* pastures. Lumbreras (2006) has noted that initial settlement sites in the Andean highlands are often found in association with *bofedales*. Although *bofedales* occur naturally, they are often associated with irrigation systems and turf walls to retain water, and the large highland areas of improved pastures, should be considered the result of thousands of years of landscape management (Palacios Ríos 1977; Dransart 2002:37; Lane 2006; Bonavia 2008:53).

4.1.9 The built landscape – Inka architecture

The importance of architecture in the imperial enterprise of the Inka can hardly be exaggerated. Architecture was an essential element in the Inka colonization program, and the spatial organization of both provincial Inka centers, and the royal estates of the Cuzco region, were constructed to create "a landscape of inequality" (Acuto 2011:36). Architectural construction methods were clearly not used only for practical reasons, but to articulate identity and status. Specific types of masonry were used to further communicate meaning, and this was particularly obvious in the architecture of royal estates, or palaces, which were prominent features of the Inka landscape. At Chinchero, for instance, believed to be the private estate of

Topa Inka, the interior architecture was made of fine masonry. A few select walls of very fine coursed, ashlar masonry, surrounded by walls of polygonal fine masonry, comprised the sacred core of the estate and symbolized Inka elite space and "[b]eyond lay a vast landscape of mortared masonry, serving as a foil to the exclusive royal center" (Nair 2015:28). In general, the royal Inka estates were created as a reflection of the Inka view of a perfect social order, where the "Inca and the Sun are attended by fleets of *mamaconas* and served by workers, house servants, guards, and weavers from throughout the empire" (Niles 1999:152-153). The royal estates were palaces where the Inka rulers periodically resided, but as Morris (2004:299) has pointed out:

> from a social and political point of view, the residential functions are secondary to the symbolic and ritualistic importance of palaces as the focus of power and authority. When a subject is in a palace, or even sees one from a distance, there is, or at least should be, the sense of awe that is the crux of the behavior of civic obedience.

Accordingly, the essential purpose of monumental architecture is to discipline those who look upon it. Trigger (1990) has provided a similar explanation for why monumental architecture seems to be universally present in complex societies or "civilizations". It is because the

> ability to expend energy, especially in the form of other people's labour, in non-utilitarian ways is the most basic and universally understood symbol of power. Monumental architecture and personal luxury goods become symbols of power because they are seen as embodiments of large amounts of human energy and hence symbolize the ability of those for whom they were made to control such energy to an unusual degree (Trigger 1990:125).

At the most general and fundamental level "political power is universally perceived as the ability to control energy" (ibid.). Salazar and Burger (2004:330) note that the building of monuments was a "popular medium through which the Sapa Inca could demonstrate his ability to mobilize and control labor." As an example of the crucial link between a ruler's power and palace construction, Salazar and Burger refer to Betanzos,[21] who writes that

[21] Juan de Betanzos (1996[1551]) was one of the Spanish chroniclers. Because he married a daughter of Atawalpa Betanzos had good insights into Inka elite life, but for the same reason his accounts reflect a view of Inka society and history from the perspective of his wife's kingroup and political fraction of the Inka elite.

Wayna Qhapaq asserted his authority when he commanded 150,000 workers to build his palace at Yucay. In contrast, the weakness of Atawalpa[22] was made manifest when he was unable to command enough labor to construct his palace in *Tomebamba*, in Ecuador (Niles 1999:80; Salazar and Burger 2004:330).

The imperial Inka architecture also included the royal road system, the Qhapaq Ñan. The main roads were paved, stepped, or tunneled, depending on the terrain (Protzen 2000:193; Hyslop 1984), and radiated from Cuzco in four directions to the four *suyu* constituting Tawantinsuyu, each *suyu* name also referring to the road leading in its direction (Julien 2009:104). The Inka road system was not limited to roads, but also included other infrastructure, such as the *tampu* waystations and the larger administrative centers such as Huánuco Pampa. These centers also had huge storage facilities, *qollqa*, where the Inka subjects delivered their produce. Julien (2009:109) quotes Betanzos about the ordinances given to Inka captains sent out on military campaigns, and it is worth quoting at some length:

> The captain was to establish posts along the road so that he could communicate with Cuzco; the posts were to be supplied by local people. He was also to create *tambo* or 'lodging-places' for the army, where a group of assigned women were to prepare food and brew beer for their sustenance. A transport service staffed by local people was also to be established; those assigned to serve in this manner were to be responsible for transporting loads from their *tambo* as far as the next *tambo*. The captain was also instructed to build a major center called a *Xuco Guaman* every [220 km]… …with greater storage capacity and assigned herds, presumably so that armies could be hosted for longer periods.

The Inka road system, with its attached infrastructure, was the system of arteries feeding the heart of the empire, bringing labor and energy from the provinces to Cuzco. But this imperial architecture was not simply what facilitated imperial metabolism, it was also in itself an integral part of the process of appropriation of land and labor. The number of new installations founded by the Inka state during the relatively short period of expansion was impressive and extraordinary compared to other ancient cultures (Gasparini and Margolies 1980:100-101). However, considering the nature of Inka

[22] Atawalpa had just won the title of Inka when the Spaniards arrived. He was captured and executed by the conquistadores.

expansion, and the ability of the Inka state to appropriate and control labor, it is in no way implausible, and as Gasparini and Margolies suggest, it "could have been accomplished at an accelerated rate." In this respect it is interesting to note that, according to Betanzos, the ninth Inka ruler, Pachakuti,[23] gathered only the local lords of Cuzco to build the Qorikancha. His successor Topa Inka is said to have gathered not only the local lords, but leaders from the whole country, and ordered them to bring their best builders from all regions to Cuzco, to construct his palace estate at Chinchero (Betanzos quoted in Bengtsson 1998a:10). Wayna Qhapaq, Topa Inka's successor, is said to have ordered 100,000 people to construct his estate at Yucay. Within six months 150,000 workers reportedly came to the site. There is a clear tendency of accelerating appropriation of labor evident in these historical reports.

[23] In the official Inka genealogy, the three Inka rulers responsible for the expansion of the Inka Empire were Pachakuti (approximately 1438-1471), Topa Inka (1471-1493), and Wayna Qhapaq (1493-1528) (Julien 2009:105). See also Table 4.1

5. Case studies: textiles, *chicha,* and stone walls

Having outlined the central theoretical foundations and methodologies framing this thesis and given a brief overview of the Inka Empire and the Andean landscape in general, in this section, I finally come to the case studies themselves.

In what follows I will present three case studies of “things” – items of material culture – produced in the Inka Empire. Karl Marx observed that relations between people can present themselves as things. While human social relations are often understood as immaterial or experiential, by reconstructing the *material* biography (cf. Kopytoff 1986) of these things, and measuring their biophysical extensions in the world, the material dimensions of these relations will be made tangible.

The making of things is always both a material and a cultural or symbolic process, and distinct cultural systems therefore “are expressed through systems of techniques” (Lau 2010:259). This is why archaeologists may recognize different cultures, and perhaps even individual members of those cultures, in the material record. The production process itself will therefore also be perceived in distinct ways, as well as the “things” themselves. As we have seen, indigenous Andeans tend not to perceive of “things” as objects in the sense that Western people are socialized to do (cf. Hornborg 2006b). Some things are perceived as persons (cf. de la Cadena 2015; Sillar 2009). In the Andes, as Allen (2002[1988]:126) puts it: “Any manufactured object has gone through a transformation from raw material to finished product, during which its maker – the *kamayuq*, the one who possesses creativity - imbues it with a selfhood that must be treated with respect.” Allen asserts that this notion is an old one in the Andes, exemplified by the Moche ceramic iconography depicting the so-called revolt of objects (Quilter 1990; Allen 1998).

The *kamayuq* of Tawantinsuyu were attributed with “the capacity to infuse the objects of their production with this essence of being” (Cummins 2015:182). Although often translated as “specialist,” *kamayuq* literally means “possessor of a specific force or energy” (ibid.). The making of fine objects in the Inka Empire was thus considered a sacred act as much as it was a craft performance (ibid.,173).

Textiles also “take on selfhood” (Allen 2002[1988]:126) and come alive in the fabric in a way that makes Andean textiles more complex than “clothes or rags in other cultures” (Cereceda 1986:163; Silverblatt 1978:42). These special qualities of textiles in the Andes can help explain why they were so important in Inka ritual as well as in Inka political economy, and why the Inka would rather have their textiles burned than end up in European hands. Enormous quantities of textiles were produced in the Inka Empire, a large portion to be consumed in sacrificial burnings.

Textiles were the most important signifier of identity and social status among Andean people (D’Altroy 2002:295). Cobo reported, for instance, that people would be severely punished if they did not wear the special emblems, clothes, and headdresses by which they could be identified (D’Altroy 2002:295). Of all the royal insignias, textiles were particularly important in signaling royal authority (Salazar and Roussakis 2000; Salazar and Burger 2004:327), and weaving was perhaps the most valued art in Tawantinsuyu (D’Altroy 2002:290).

Chicha, as we have already seen, was a means of communication with the supernatural and sacred. It was also the main form in which labor service to the state was compensated, and it formed a central ingredient in the ceremonial feasting which was the arena in which political relations in the Empire were enacted. *Chicha* was consumed in massive quantities in the Inka Empire, not least by the Inka elite. Although few descriptions of Inka elite life have been recorded, those that exist tell of numerous festivals involving dancing, singing, feasting, and drinking. Several of the historical accounts mention the primacy of drink rather than food in Inka consumption habits; most meals soon gave way to drinking (Salazar and Burger 2004:347-8).

The third and last case study looks at the labor and land requirements of constructing stone walls in the Inka Empire. “Walls are at the foundation of civil society,” writes Sillar (2013:27), constituting “physical and symbolic barriers that differentiate people and activities.” The fine masonry Inka walls

are rightly famous, and must be counted as an emblematic signature of Inka power. More than that, it has been suggested that the Inka elite may have believed themselves to be animated by the same life-force or energy (*kamaquen*) as stone, and that the Inka thus viewed themselves "as the tangible instantiation of the power of stone, sharing the animate 'stoney essence' of durability, permanence, and ubiquity with this important elemental material of the Andean world" (Bray 2009a:363). Like all monumental architecture, Inka stone walls signaled social surplus (Moore 1992), and constructing stone walls and monumental architecture of all kinds was one of the major tasks carried out by Inka subjects doing their *mit'a*.

In the following three case studies, the production of these emblematic Inka artifacts is reconstructed in order to answer the questions of how much time and space the Inka elite appropriated through the production processes and from whom. Answering these questions simultaneously will shed light on the issue of why Andean people were devoting such a large portion of their time and resources to continually reproducing their inferior position as subjects of the Inka lords.

5.1 A note on the generalization of standards for calculation

Before presenting the case studies, a short note is in order on the standardizations I have used in my calculations. Measuring labor only in units of time, for instance, leaves out other aspects, such as the level of physical exertion demanded, the energy expended, the potential to conduct other tasks simultaneously (multi-tasking), whether the labor was carried out under stressful or perhaps hazardous circumstances, and so on.[24] The time it takes a person to carry out a certain task depends on a number of things, including skill, training, physiology, age, health, and attitude. In order to make the kind of calculations I do in the case studies, it is necessary to establish generalized standards, for instance average caloric requirements, or

[24] In her study of prehispanic stone work in Peru, for instance, Bengtsson (1998a:90-3) discusses the conditions for workers in the Kachiqhata quarry in the vicinity of Ollantaytambo, and concludes that "an unskilled mason's life was maybe not worth very much."

number of hours in a normal working-day, for Andean laborers. Although people will have worked both longer and shorter days, the point has been to arrive at reasonable estimates of duration and capacity for particular tasks, such as the length of a *sustainable* agricultural work-day or weight of carrying loads, that is, which could be applied continually without seriously and permanently affecting people's health and well-being.[25]

In the contemporary highland community of Nuñoa, a day of agricultural labor involves on average 6.5 hours of active labor, and herding involves 8 hours of labor (Thomas 1972:116). Protzen (1993), when discussing the effort involved in stone work, calculates a labor day of 7 hours and Treacy (1994), based on actual observation in the Andes, and considers 6 hours to be the average for a day of stone construction work. I will follow Treacy's estimate of 6 hours in my calculations. For spinning and weaving, as well as the domestic labor involved in *chicha* brewing, I assume a labor day of 8 hours to be reasonable, although the repetitive movements involved in this kind of work will cause health problems if carried out daily over long periods of time. Accepted measures of walking speed in the Andes seem to be 5 km per hour, and 3 km per hour for slow walking (Thomas 1972; D'Altroy 1992). To drag large stone blocks I have set the pace of progression at 10 percent of normal walking speed or 0.5 km per hour. The issue of how loads were carried, and transport capacity, in the Andes has been a matter of constant scholarly debate, and estimates vary widely (Hyslop 1984:294-98). Camelids, llamas in particular, were used as beasts of burden, and llama caravans transported goods over long distances. Huge flocks of llamas accompanied the Inka army for example. Llamas can only carry limited loads, however, and human porters probably played the major role in transport in the Inka Empire (D'Altroy 1992:85). How large and heavy loads porters would carry is also a matter of dispute. Modern observations of professional porters have shown that they may carry their own weight even up steep slopes, but then only for limited time intervals. D'Altroy (1992:83-90) deals with the issue at some length, and concludes that a reasonable upper limit for carrying loads over long treks is 30 kg, covering a distance of approximately 20 km a day. Some historical sources report much longer distances covered and heavier loads carried, but there are also reports from early colonial times that porters could not be forced to carry loads larger than

[25] It should also be kept in mind that cultural perceptions of work, leisure and hardship were not necessarily the same in the Andes as in the Western cultural tradition (Harris 2007).

30 *libras* or approximately 14 kg (D'Altroy 1992:85). I will assume that the average daily transport capacity of a human porter in prehispanic times was 20 kg for 6 hours a day.

I am also operating with some general assumptions about geographical, demographic, and organizational conditions in Tawantinsuyu. Although the borders of Tawantinsuyu were porous and shifted throughout the history of the empire, the area covered by the Inka Empire at its maximum extent is often stated to have been some two million square kilometers. I will use this generalization in my calculations. The size of the indigenous population before the arrival of the Europeans and the illnesses that they brought to the region is unfortunately not known. N. Cook (1981) synthesized the arguments and the various methods that have been used to base population estimates on. As N. Cook notes, the Inka administrators probably had this information recorded in their *khipu*, but modern estimates of the prehispanic population in the area which is now Peru have ranged between three and 32 million (ibid., 11-13). Many Andean scholars, however, seem to assume that the population of the Inka Empire in the years before the European invasion was somewhere between 10 and 12 million, and I will use the figure 10 million in my calculations. Neither is there any reliable information or evidence as to how large a proportion of the population was defined as Inka by "blood" (i.e., ethnically) or "privilege." Estimates have ranged between 15,000 and 40,000 (McEwan 2006:93; Moseley 1992:9), and the figure of 25,000 individuals is often used. Another factor of importance is the number of households in the Inka Empire, since the individual household was the basic unit for tax collection. Again there is no consensus, but assuming that each household consisted of five people, a population of ten million would imply two million households (e.g. Kolata 2013:111). Since every household consisted of at least two adults, a married couple, the figure of five people per household seems low. There is also historical information suggesting that households became larger during Inka times, precisely because it made it easier for the households to fulfill their tax obligations to the state. Keith (1976) for instance believed a number of six to ten people was a plausible estimate for household size in the Inka Empire. Since I am assuming a total population of 10 million people, it seems reasonable to operate with a figure of 1 million tribute owing households.

5.2 Textiles[26]

The archaeological and historical records from the Andean region of South America contain plenty of evidence of the economic, political, and ritual importance of textiles in the ancient Andes. In the coastal regions the primary raw material for making textiles was cotton, and in the Andean highlands camelid fleece was the most highly valued raw material (A. Rowe 1997:6; Boytner 2004:133).[27,28] Complex relations of trade and exchange of coastal cotton and highland fleece appear to go back at least as far as the Early Horizon (Dwyer 1979:74), and many archaeologically recovered textiles are made from both cotton and camelid fleece. The dry climatic conditions of the coastal regions favor preservation of ancient textiles, and ancient coastal sites have revealed magnificent textiles produced in the Andes over thousands of years. Most famous is probably the so-called Paracas necropolis, where Peruvian archaeologist Julio C. Tello in the 1920s found numerous mummy bundles wrapped in large quantities of embroidered cloth, which had been buried at the site some two thousand years ago. Most of the preserved prehispanic textiles now found in private and museum collections around the world, including those belonging to the Inka period, have been recovered from coastal sites. More recently, the search for ancient sacrificial sites in the high Andean mountains, where the climatic conditions are also optimal for preservation, has yielded interesting information on textiles and dress in late prehispanic times (Reinhard and Ceruti 2000, 2010).

[26] A previous version of this case study was published in Bogadóttir (2012)

[27] There are four camelid species native to South America; the wild guanaco and vicuña, and the domesticated llama and alpaca (see e.g. Stahl 2008; Bonavia 2008). Moreover, archaeological investigations of late prehispanic camelid remains have suggested that different varieties of llama and alpaca were bred specifically to produce different qualities of fleece (Wheeler et al. 1995; Wheeler et al. 1992). Although fleece from all camelid species was used in the Andes, the focus here is on the exploitation of llamas and alpacas.

[28] Many other fibers were used and spun in the Andean area (see e.g. Bird 1979), but they will not be dealt with further here.

5.2.1 Inka textiles in historical perspective

Although Inka myth associated clothing with Inka civilization, for instance in the legends of Mama Ocllo, who supposedly taught Andeans to dress, spin and weave, the Andean art of weaving began as early as 4500 BC (Phipps 2004a:18). Inka textile production built on these earlier Andean traditions, and woven tapestry was used as an elite symbol of power by at least three highland polities before the Inka: Recuay, Wari, and Tiwanaku (Rodman and Cassman 1995). In comparison with these earlier traditions, however, Inka fine textile production shows a highly selective, restricted, and standardized approach to design as regards choice of color, specific sets of geometric motifs, weaving technique, and size of garments (Phipps 2015).

5.2.2 The role of textile in the Inka political economy

In 1532, when Francisco Pizarro and his conquistadores invaded Tawantinsuyu, the historical sources report that they observed camelid herds along the coast (Shimada and Shimada 1985:17). The historical data together with existing archaeological evidence strongly suggest that camelids were much more widespread than is the case today (Bonavia 2008; Lane 2006; Rostworowski 1999:197; Novoa and Wheeler 1984; Flores Ochoa 1977a; Shimada and Shimada 1985, 1987). In the Inka storehouses, the so-called *qollqa*, the Spanish invaders found enormous quantities of textiles and camelid fleece (Murra 1962:717). The Spaniards were amazed at the quality of Inka textiles; the chroniclers describe cloth as fine as silk, superior to fabrics produced in Europe at the time (Murra 1980:66-67). But the socio-economic significance of camelids, fleece, and textiles in Andean society probably evaded the Spaniards' attention. According to Juan de Betanzos, when news of the arrival of the Spanish first reached Atawalpa, his first questions about these strange newcomers and their leader Pizarro were "what type of man he was and how he was dressed and what kind of garments he wore and how they looked" (Phipps 2015:207). The Spaniards, on the other hand, inquired about gold and silver, the materials and artifacts of greatest importance in their own contemporary European society. As Murra (1962:721) writes, "[t]here is nothing strange in the political use of prestige objects; the novelty consists in discovering that, in the Andean area, the artifact of greatest prestige and thus the most useful in power relations was cloth." Camelids and their fleece were of central importance to the Inka. A

few years before the arrival of the Spaniards, before embarking on one of his numerous military campaigns, the Inka ruler Wayna Qhapaq received a report on his camelid herds and the quantity of fleece they produced annually (Murra 1980:53). The reason why this seemingly rather trivial report has survived long enough to reach us today is because camelid fleece was essential, not only for the success of the Inka's military campaign, but for the continued expansion and reproduction of his entire empire. Camelid fleece, and its transformation into cloth, was a crucial element in Inka imperial metabolism, and a means by which the Inka appropriated human labor time and ecological space. The main aim here is to arrive at an estimate of *how much* space and time the Inka were able to appropriate in this manner.

The people who have become known as the Inka were until around AD 1000 only a geographically confined group of maize farmers inhabiting some valleys in the southern highlands of what is now Peru. By around AD 1400, however, the Inka state had extended its control over most of the Cuzco region, and began its imperial expansion campaigns (Covey 2008). Within only about a century, the small Inka state grew into an empire which can be described as a world-empire (Wallerstein 2011 [1974]). The Inka Empire has also been described as a world-system in the sense that there was labor exploitation and resource extraction in the periphery conducted by a core polity, and a division of labor based on strict ethnic and class distinctions (Kuznar 1996). The production as well as the consumption of textiles played an important role in the organization of these social distinctions. Ethnic identity and social status within society was signaled through dress, and therefore strict dress codes had to be followed; if they were not followed, severe punishment ranging from beating to death could be expected (Costin 1998a:123-124). People of high status received fine *qompi* cloth from the Inka while commoners were gifted with coarse *awasqa* cloth (Murra 1962:720). Both the common *awasqa* cloth and the fine *qompi* thus served as crucial items in the Inka gift economy. The differentiation of elite and common fabrics in the Inka Empire also served to differentiate Inka-by-blood and Inka-by-privilege from Inka subjects or commoners (Phipps 2015:201). The same strict divisions guided the production of textiles. Through the Inka labor tax system, the Inka state involved practically everyone under their rule in textile production. Certain categories of people were officially exempt from tax obligations, but there is historical evidence suggesting that even elite households produced and delivered textiles to the Inka every year (J. Rowe 1979:239). Fleece was provided to the common people to be used to

weave coarse cloth for the state and for themselves; the chroniclers write that the common people in the Inka Empire were constantly busy with spinning and weaving (Murra 1962:716). In addition to the work done in the common households, the *aqlla* and the *qompikamayuq* also produced textiles for the Inka state. The large quantities of woven textiles were stored and redistributed by the Inka state as gifts; *awasqa* textiles were awarded to common people in return for certain services that they provided to the state, and *qompi* to Inka and other nobles. In certain cases, *qompi* could also be given to commoners in reward for some special service or loyalty (Boytner 2004:131,139). Because of the vital role that textiles played in exchange and power relations, the Inka state needed a constant supply in order to be able to initiate new reciprocal relations and maintain existing ones. The Inka state met this growing need by expansion and intensification: expanding the imperial labor force through incorporating new populations into their tax system, and demanding more labor from their subjects. Additionally, the establishment of separate occupational classes of workers such as the *qompi kamayuq* and the *aqlla* has been interpreted as another Inka strategy to intensify production. The Inka ruler coaxed people to produce textiles, which were then redistributed as value-added goods, placing himself and the state in the role of provider and benefactor of the people. A tunic from the Inka was a prestigious and highly valued gift, and because dress was so closely associated with identity and status, the gift defined both donor and recipient. Simultaneously, it obliged the recipient to reciprocate in a certain manner. Very tellingly, we learn from the chroniclers that when the Inka had conquered new territories, his first act was to present the newly conquered people with gifts, often textiles. As Murra (1962:721) writes, this can either be seen as the benevolent act of the generous conqueror, or as the initial pump-priming step of a new dependency relation.

The conventional view of the Inka tax system, expounded by the Inka elite to the Spanish chroniclers, was that people contributed solely their labor, or time, to the Inka state (J. Rowe 1946:265). Although the Inka cultural model of their economic system did not acknowledge that tribute was paid in kind, the figures listed in Table 5.2.1 are estimates of how much labor time, and how much geographical space, could be appropriated through the textile tax and other culturally sanctioned forms of exchange involving textiles and camelid fleece.

Many scholars of Andean society have written about the importance of cloth and remarked upon the "incalculable" (Murra 1962:713) hours of work that must have gone into textile production. Some have specifically warned that knowledge of ancient textile production is too limited, and variation so great, that any attempt at estimating production rates would, at best, be fruitless (Gayton 1967:279; Franquemont 1986:322). Taking all this into account, and acknowledging that variation and nuances are lost in such analyses, if we want to understand the political ecology of ancient societies, there are nevertheless good reasons for making such attempts.

Example 5.2.1 Awasqa and compi tunics

Only few ethnographic studies and estimates of the labor requirements of Andean textile production have been published (e.g. Bird 1969; Franquemont 1986), and these studies have previously been used to discuss prehispanic labor demands of textile production (see e.g. Costin 2015). To my knowledge, however, there has not been any systematic attempt to distinguish between the labor requirements of the production of common versus fine textiles which is done here. Calculations of embodied labor and land, time and space, are here made for the two categories of textiles recognized by the early colonial sources as produced in the Andes during Inka times: *Awasqa* is described in the colonial reports as "coarse and thick," and *qompi* as "very fine and precious" (A. Rowe 1997:9). Fine textiles are often described as tapestry referring to the weaving technique, but there is some controversy as to how they should be defined (see e.g. J. Rowe 1946:242; Desrosiers 1986:229; Costin 1998a:124-125; A. Rowe 1997:9-10). It must be emphasized that the quality and fineness of cloth as well as the production methods varied greatly, and that the figures and criteria I use in my calculations are approximations based on the available sources. I have chosen to base my calculations on the so-called *unku*, which was a knee-length tunic. The reason why the tunic is chosen over some other piece of garment is because it was a standardized piece of cloth, worn by most Andean men, and it was also part of the Inka tax and redistribution system (A. Rowe 1992:5).[29] The criteria I have used to determine size and thread count in my examples of

[29] Women's dress, *anacu,* was similarly woven as a rectangular piece of cloth, and wrapped around the body. While quite a lot of information and research has been made on the *unku*, women's garments are not as easily recognizable archaeologically, and much less is known about them. However, recent discoveries have added much new information on women's dress (Phipps 2015).

awasqa and *qompi* tunics are found in the article by J. Rowe on "Standardization in Inca Tapestry Tunics" (1979), and in A. Rowe's articles on "Technical Features of Inca Tapestry Tunics" (1978) and "Inca Weaving and Costume" (1997). The size of fine Inka tunics varies between 168 and 200 cm in the weft direction, and 72 and 79 cm in the warp direction (J. Rowe 1979:245), and I therefore use an average measure of 184 cm in the weft direction and 76 cm in the warp direction. I use this same size measure for the *awasqa* and the *qompi* tunics.[30]

The calculated average weft count of the *qompi* tunic is 80 per cm, and the warp count is 12 per cm, or 92 per cm^2 in total. I have not been able to find much information in the literature on the typical thread count of *awasqa* cloth, but it seems reasonable to suggest that *awasqa* was roughly three to four times coarser than *qompi* (see e.g. A. Rowe 1978:5, 25; A. Rowe 1997:9). Therefore, I have simply defined the *awasqa* tunic as four times coarser than the *qompi* tunic, with a total thread count of 23 per cm^2 (18 warps and 5 wefts). As it happens, this corresponds rather well with a plain-weave poncho described by Franquemont (1986) in his study on production rates of traditional textiles in the Andes. As Inka textiles were almost exclusively woven with two- or three-ply yarns (A. Rowe 1997:6), the warp in finer cloth often being three-plied and more tightly twisted to add strength to the yarn (A. Rowe 1978:7), I have calculated with two-ply yarn for both weft and warp in the *awasqa* tunic, and with two-ply weft yarn and three-ply warp yarn in the *qompi* tunic. The estimated weight of the *qompi* and *awasqa* tunics is based on figures on thread count and average weight of yarn in the study by Franquemont (1986:317, Table 3). The approximate weight of the finished *awasqa* tunic would be around 1.5 kg. Assuming that the *qompi* yarn is four times finer, the weight of a finished *qompi* tunic would be 0.375 kg.

[30] This calculated average of the size of an Inka *unku* or tapestry tunic (184cm × 76cm = 1.4 m^2) in fact corresponds exactly to textile panels excavated from a small storage structure associated with the Inka administrative center in the Acarí Valley, Tambo Viejo. The textiles recovered from this cache were of medium to low quality (Phipps 2015) and clearly standardized in size, shape and quality, probably collected from tax-payers. The textile panels were of two different sizes, the larger ones measuring on average 1.4 m^2 (Katterman and Riddell 1994; Costin 2015:58).

Another assumption made in these calculations is that *awasqa* was made with llama fleece and *qompi* was made with alpaca fleece.[31] The reason for this is that, generally speaking, alpaca fleece is finer than llama fleece, and although there is evidence that llamas were also bred to produce finer fleece during the Inka period (Wheeler et al. 1995), it is still reasonable to assume that alpaca fleece was generally of a higher quality than llama fleece. Topic et al. (1987:832) write that although there is a "considerable range of variation in the fineness of wool produced by llamas and alpacas in general, and by any given animal on different parts of the body … if large scale production of fine wool is a goal, it is more efficient to collect it from alpacas than from llamas." Also, there is general agreement that the production of fine (alpaca) fleece is dependent on certain pastoral conditions, viz. those of the highland *bofedales* (Topic et al. 1987; Flores Ochoa 1975, 1977a; Dransart 2002). Camelids require nutritive and succulent vegetation to produce soft fleece, and particularly alpacas are vulnerable to drought and other environmental factors. To maintain their health, and produce abundant fleece, alpacas need to graze on *bofedal* pastures that maintain adequate vegetation year round. Llamas, on the other hand, can be sustained on the dryer *pampa* pastures (Kuznar 1991a:3). I therefore make the generalization that *qompi* production required *bofedal* pastures, while *awasqa* production required *pampa* pastures. The difference between a hectare of *pampa* and a hectare of *bofedal* is one of both quantity and quality, i.e. the net primary production in *bofedales* is larger, and the quality of the forage is higher (Quispe et al. 2009; Kuznar 1991a, 1991b). Because of this, the production of fleece is also higher in the *bofedal* and the hectare requirement thus lower. However, the lower hectare requirement should be considered in its relevant context, as the total *bofedal* area available is much smaller than the total *pampa* grazing area.[32]

[31] The archaeologically recovered examples of fine Inka tunics are in fact often made with a strong tightly spun cotton thread as warp, and camelid thread weft. Rodman and Cassman (1995:34) write that the warp yarns in Inka tunics were usually three-ply yarns made from either cotton or camelid fiber. The calculations here are however based only on camelid fiber.

[32] In modern day Peru, the *bofedal* area is estimated to be approximately 2.5 percent of the total pasture area (MINAM 2010, 2012).

Table 5.2.1
Ecological space (ha) and labor time (hours) embodied in Inka textiles.

	Awasqa cloth (per tunic)	Qompi cloth (per tunic)
Space (ha)[a]	1.92 ha (*pampa* pasture)	0.13 ha (*bofedal* pasture)
Time (hours)[b]		
Herding[c]	52 hours	6.2 hours
Shearing[d]	0.5 hours	0.1 hours
Dyeing[e]	0 hours	203 hours
Spinning[f]	95 hours	403 hours
Plying[f]	31 hours	121 hours
Weaving[g]	54 hours	2,026 hours
Total	233 hours	2,759 hours

Notes to Table 5.2.1

a. Space: The calculation of space (land) embodied in *awasqa* and *qompi* cloth, is based on figures on annual llama and alpaca hectare (ha) requirements for grazing and annual fleece production. Kuznar (1991b:337) writes that llamas require 1.75 ha of *pampa* pasture, while alpacas require 0.63 ha of *bofedal* pasture. The estimated annual fleece production is 1.5 kg for llamas and 2 kg for alpacas (Quispe et al. 2009). Because of waste in the process of yarn production, which according to Quispe et al. (2009:4) is 9 percent, the amount of fleece needed to produce one tunic is 1.5 / 0.91 = 1.6 kg. Taking into account this loss, it takes 1.6/1.5/ ≈ 1.1 llamas to produce fleece for 1 *awasqa* tunic. Likewise, assuming one *qompi* tunic weighs 0.375 kg, the amount of fleece required is 0.375/0.91 = 0.41 kg. Producing fleece for one *qompi* tunic therefore requires 0.41 kg/2 kg = 0.21 alpacas. The area needed to produce fleece for one coarse *awasqa* tunic is thus 1.1 × 1.75 ≈ 1.92 ha of *pampa* pasture, and the area needed to produce fleece for one fine *qompi* tunic is 0.21 × 0.63 ≈ 0.13 ha of *bofedal* pasture.

b. Time: The tasks I have included in my estimation of the labor time involved in textile production are: herding, shearing, dyeing, spinning, plying, and weaving, leaving out factors such as washing, skeining, warping, and finishing (sewing, embroidering, etc.). These factors are left out because they are difficult to assess, but if included they would add significantly to the production time, which means that my figures must be considered conservative. The production rate estimates are based on two published studies on production rates of traditional Andean textiles. The data for the first study were collected by Grace Goddell in the Pisaq area and analyzed

and published by Junius B. Bird (1969). A second study was carried out by Franquemont (1986) in the community of Chinchero in 1977 with the same methodology as the study by Goddell and Bird and with the aim of "filling in the blanks" of that former study (Franquemont 1986:309). In both communities, traditional methods of weaving and spinning were still in use. Franquemont (1986:322) mentions specifically that the results are not directly applicable to prehispanic contexts such as *qompi* tapestry weaving. My own calculations of prehispanic production rates are mostly based on these two studies. Where it is possible and appropriate, I use other sources.

c. Herding: The figures on herding are derived from studies made in the community of Chinchillape. Kuznar (1991b:377) estimates that 8 minutes per animal per day is needed to herd llamas, and 5 minutes per animal per day is needed to herd alpacas. The herding labor involved in producing one *awasqa* tunic requiring 1.6 kg of fleece therefore required 1.6 / 1.5 × 8 × 365 = 3,115 minutes or 52 hours. The herding labor involved in producing one *qompi* tunic, requiring 0.41 kg of fleece required 0.41 / 2 × 5 × 365 = 374 minutes = 6.2 hours.

d. Shearing: The figures on shearing in Franquemont's (1986:312) study appear to be rather high, as the shearing of around 1 kg of fleece requires approximately 90 minutes. Thomas (1972:120, Table 18) has measured the annual labor involved in shearing 100 camelids in the Andean highland community of Nuñoa to be 2,730 minutes (45.5 hours). Since 100 llamas could produce 1.5 kg × 100 = 150 kg of fleece annually, or enough to produce 150kg/1.6kg = 94 *awasqa* tunics, labor requirements per tunic would be 2,730 minutes / 94 = 29 minutes or 0.49 hours. Since 100 alpacas could produce 200 kg of fleece annually, enough to produce 200kg/0.41kg = 488 *qompi* tunics, labor requirements involved in shearing would be 2,730 minutes / 488 = 5.6 minutes or 0.09 hours.

e. Dyeing: Although the archaeological record holds plenty of evidence that Andean people have dyed their garments for thousands of years, the traditional dyeing methods were largely abandoned by the nineteenth century, and little is known of the exact procedures, let alone how time-consuming they were. The question of production rates of dyeing can be approached from another angle, however. Catherine Julien (1988) in her work on the Inka decimal administration system has reconstructed the labor obligations imposed by the Inka on the Chupachu. Julien lists the different assignments and how large a percentage of the total population each assignment

demanded. The figures show for example that 10 percent of the 4000 tax-owing households were to work as "Weavers of tapestry (*cumpi*) cloth" and 6 percent (240 households) as "Herders of Inca herds," while 1 percent (or 40 households) were to work off their labor tax as "Dye makers" (Julien 1988:265). If we use the figure calculated in Table 5.2.1 for weaving of one *qompi* tunic, which was 2,026 hours (see also note g), the labor requirements for dyeing should be one-tenth or 203 hours. Since commoners wore undyed clothes (Costin 1998a:128, but see also A. Rowe 1997:9), I have only added this figure to the production time for *qompi,* not *awasqa*.

f. Spinning and plying: In order to estimate the labor time involved in spinning and plying, I have calculated the yarn length and the length of single thread in a piece of *awasqa* and a *qompi* tunic, respectively, and used Franquemont's figures on production rate. With an average spinning rate of 1.3 meters per minute (Franquemont 1986:317), an average plying rate of 1.8 meters per minute (Franquemont 1986:316), and reckoning with a 10 percent reduction of the warp because of weft insertion (Bird 1969:14) and an 11 percent reduction in the plying process because of the twisting (and therefore shortening) of the yarn (Franquemont 1986:318), the labor time can be calculated thus:

The length of single thread in one *awasqa* tunic sized 184 cm × 76 cm, with a thread count of 23 per cm^2 [5 weft yarns and 18 warp yarns and made with two-ply warp and weft yarns] is (184 × 76 × 5 × 2 / 0.89 / 0.9) + (184 × 76 × 18 × 2 / 0.89) ≈ (174,582 + 565,645) cm ≈ 7,402 m. The spinning time for this tunic is 7,402 / 1.3 / 60 ≈ 95 hours. The yarn length is (184 × 76 × 5 / 0.9) + (184 × 76 × 18) ≈ (77,689 + 251,712) cm ≈ 3,294 m. The plying time is 3,294 / 1.8 / 60 ≈ 31 hours. The length of single thread in one *qompi* tunic sized 184 cm × 76 cm, with a thread count of 92 threads per cm^2 [12 three-ply warp yarns and 80 two-ply weft yarns] is (184 × 76 × 12 × 3 / 0.89 / 0.9) + (184 × 76 × 80 × 2 / 0.89) ≈ (628,494 + 2,513,978) cm ≈ 31,425 m. Spinning time for this cloth is 31,425 / 1.3 / 60 ≈ 403 hours. The yarn length is (184 × 76 × 12 / 0.9) + (184 × 76 × 80) ≈ (186,453 + 1,118,720) cm ≈ 13,052 m. The plying time is 13,052 / 1.8 / 60 ≈ 121 hours.

g. Weaving: Of all the uncertain production rate factors used in this study, the weaving rates are probably the most problematic. Figures vary dramatically with different weaving methods and techniques, not to mention the complexity of design and pattern and the weaver's familiarity with it. To estimate the weaving time for an *awasqa* tunic, I use the figures arrived at in

Franquemont's study. Franquemont's (1986:312, Table 2) figures show that yarn preparation (shearing, spinning, dyeing, and plying) amounts to around 70 percent of total production time of a plain weave poncho. Assuming that a plain weave poncho corresponds in quality and production method roughly to an *awasqa* tunic, we may therefore deduce that the weaving of an *awasqa* tunic demanded 126.5 x 0.3 / 0.7 ≈ 54 hours. In the study by Goddell and Bird, weaving is considerably more time-consuming, probably because of the more elaborate pattern and the difference in weaving method. Goddell's data show that one weft insertion in a 140 cm long patterned poncho takes on average 15 minutes (Bird 1969:14-15). From that we may deduce that one weft insertion in our 184 cm long *qompi* tunic would take an average of 20 minutes. As there would be 80 weft insertions per cm this would require 76 × 80 × 20 minutes = 2,026 hours.

5.2.3 Who made the textiles?

When it comes to the division of labor in the Inka Empire the historical sources are somewhat contradictory, but it is likely that commoner women performed many of the tasks listed in Table 5.2.1. According to Inka census categories spinning was mainly a female occupation, whereas herding was carried out by young boys and men and young girls. Plants for dyeing were collected by young girls, and weaving of *awasqa* and spinning thread for *qompi* were tasks for adult commoner women,[33] while the weaving of *qompi* was mainly carried out by the *aqllakuna* and the *qompi kamayuq* (Costin 1998a). Commoner women thus carried out a large percentage of the labor

[33] The documentary sources are curiously silent about the production of yarn, even if it was obviously a very time-consuming and important part of textile production. A. Rowe (1980:87) writes that the "extreme uniformity" of archaeologically recovered yarn suggests that it was produced in the highlands on an industrial scale, and that production was centrally controlled. Gayton (1967:279) similarly has suggested that the "gross needs" of yarn in cloth production and the "standards of excellence" of the thread, indicate that spinners formed a separate occupational class in Inka society. There is, however, no term for spinners as there is for the specialist weavers, the *qompi kamayuq* (D'Altroy 2002:290). Costin (1998a:130) finds evidence in the documentary sources to suggest that fine thread for the production of *qompi* was spun by commoner women. Although the evidence appears contradictory, it probably reflects the variation in production between different regions and time periods. The most interesting conclusion that can be drawn from the lack of information about spinning is that although someone necessarily must have carried out this very demanding and time-consuming work, it was apparently not reckoned as a separate labor category in Inka society.

involved in textile production for the Inka state. The archaeological evidence seems to indicate the same thing, namely that the workload of commoner households in some areas increased quite dramatically as a result of Inka demand for textiles (Costin 1993, 2015). For the *aqlla* and the *qompikamayuq*, weaving for the Inka state became not only their occupation, but also their public identity.

Interestingly, in spite of the heavy requirements of cloth production and the high socio-economic value of finished textiles, the people who produced it were apparently not compensated. While other labor duties were typically rewarded by the Inka state, as when *mit'a* laborers were compensated with food and drink (Murra 1980:31), and soldiers received textiles in reward for their military service, there is no indication that textile laborers received anything in return for their labor.

5.2.4 Discussion of results

Looking at the figures in Table 5.2.1, we can now begin to answer the questions of how much time and space was embodied in Inka textiles, and from whom it was appropriated. We see that one *awasqa* tunic would embody 1.92 ha hectares of *pampa* grazing land, and 233 hours of labor time. One fine *qompi* tunic would embody 0.13 hectares of *bofedal* pasture and 2,759 labor hours. Estimated per m^2, *awasqa* cloth thus embodied 1.4 ha of pampa pasture and 166 hours of labor. Again it should be emphasized that the estimated labor requirements should be considered conservative estimates as a number of tasks involved in cloth production are not included in the calculations. The few ethnographic studies of textile production in the Andes, among them those used here by Goddell and Bird (Bird 1969) and Franquemont (1986), have shown that the total average production time per m^2 ranges between 200 and 250 hours (Costin 2015:58-9).[34,35]

If we relate the figures in Table 5.2.1 to pieces of information that can be found in the documentary sources, we may get an idea of how large an area

[34] These estimates are based only on the labor requirements of the textile labor itself, and not the labor of herding, etc.

[35] Estimating labor requirements of textile production ethnographically is challenging because of the nature of the labor, which is frequently interrupted by other tasks, and takes place in various locations (spinning, for instance, is often done while walking).

camelid herding and fleece production must have demanded. The chroniclers write, for example, that as part of their tribute obligations every household was required to deliver at least one *awasqa* tunic to the Inka state every year (Murra 1962:716; A. Rowe 1997:11; D'Altroy 2002:290).[36] If we conservatively assume that 1 million *awasqa* tunics were produced and delivered to the Inka storage facilities, the pasture land embodied in 1 million tunics would be 1,920,000 hectares or 19,200 square kilometers.

The historical sources also give us some clues as to how the Inka state redistributed the *awasqa* cloth, and what function it served in the Inka political economy. The chroniclers report that the Inka military was a major consumer of textiles; the army on the move needed clothing, blankets, and tent-making equipment, among other things (Murra 1962:717). With an army of perhaps 100,000 men (D'Altroy 2002:216-217), this must have amounted to huge quantities of cloth. Moreover, soldiers serving in the Inka army could expect two tunics annually in reward for their military service (Boytner 2004:130; Murra 1980:76). Assuming the tunics were all made from llama fleece, the camelid footprints of this particular military expenditure would be around 384,000 hectares and the labor requirement would be 46,600,000 hours.

The production of *qompi* likewise demanded large inputs of labor and land. There is limited information on which to base quantitative estimates of production, but Murra (1962:721) quotes an example from the historical sources of a *Wunu*[37] regional administrator, who received "300 cloths of kumpi and lipi."[38] The labor embodied in this quantity of cloth would be 827,700 hours, or the full time labor of more than 280 people working 8 hours a day every day of the year. We also know that sacrifice and offerings consumed "untold quantities" (D'Altroy 2002:294) of *qompi* textiles; the

[36] The amounts of cloth owed to the state by the communities and households probably varied. Several chroniclers mention that every household owed only one garment per year, but the same chroniclers elsewhere state that state demands varied and that people simply wove what they were ordered to. Murra believes that the apparent confusion in the historical documentation might derive from a confusion of different tax obligations (Murra 1962:716).

[37] A *Wunu*, or *Hunu Kuraka*, was responsible for 10,000 Inka subjects in the hierarchy of the Inka decimal administration system (Urton 2015:153).

[38] *Lipi*, according to Phipps (2004b:77) refers to "high-quality, bright, and shining fabrics, possibly made of vicuña or silk."

chroniclers write that almost every important sacrifice included fine cloth, which was burned as an offering to Inka deities (Murra 1962:714), and Malpass (1996:108) writes that ceremonies involving the sacrifice of cloth were held on a daily basis in the Inka Empire. Although there is not much information on which to base quantitative estimates, if we suppose that there were 25,000 people which were identified as Inka-by-blood or Inka-by-privilege and therefore entitled to wearing fine cloth, and further that they all received two garments annually corresponding in size and quality to the *qompi* tunic used for calculations here, it would require 6,500 hectares of *bofedal* pasture. The labor time would be close to 138,000,000 hours, implying that more than 47,000 people would have to work 8 full hours a day, every day for a full year just to produce these garments. When we consider that men wore not only tunics, but also a breechcloth and a mantle; women wore a long dress, a shawl, and a belt (J. Rowe 1946:234-235; A. Rowe 1997), and adding general household requirements of blankets, etc., we can begin to fathom just how much productive land and how large a portion of people's time textile production in general, and for the Inka state in particular, must have demanded.

5.3 *Chicha*[39]

Chicha, maize beer, played a crucial role in the imperial metabolism of Tawantinsuyu, and in this section I will calculate how much labor and land was embodied in *chicha* produced for the Inka state.

Chicha is the term that came to denote the fermented beverages consumed on a massive scale in Tawantinsuyu when the Europeans arrived. The importance of *chicha* was clear already to the Spanish chroniclers, and its cultural, social, economic, political and religious significance has long been acknowledged (e.g. J. Rowe 1946; Morris 1979). Moreover, a renewed interest in *chicha* and Andean ceremonial feasting has resulted from scholarly

[39] The term *chicha* was used by the Spanish to describe the fermented drinks so widely consumed in the Andes, but it was not the term used by the native Andeans. In Quechua, the term for the drink is *aqha*, in Aymara *k'usa*, and in Muchik *kótzo* (Prieto 2011:105). The word *chicha* is probably derived from the Carib term *chichal* or *chichiatl*. *Chichilia* means "to ferment" and *atl*, means water, but the origin of the term is still debated (see Bonavia 2013).

debates on alcohol consumption, feasting, and the more or less universal role alcohol seems to have had in the emergence and maintenance of hierarchical societies all over the world (Hayden 1995; Dietler and Hayden 2001; Dietler 2006). In Inka times, as today, *chicha* was central to the construction of people's identities and their negotiations of social relations (Sillar 2000a:103). However, *chicha* is and was not simply an alcoholic beverage with political implications; it is also a source of nutrition, and made a significant contribution to the diet (Cutler and Cardenas 1947:33). Moreover, the political and cultural demand for *chicha* in some areas completely rearranged the Andean landscape.

5.3.1 *Chicha* in historical perspective

In the Andes there seems to be a correlation between *chicha* and traits traditionally associated with "civilization." Burger and van der Merwe (1990) suggest that maize was consumed in the form of *chicha* at the site of Chavín de Huántar and possibly other Early Horizon sites (Burger 1992:108). In the Early Intermediate Period, evidence from sites such as San José de Moro on the north coast of Peru and perhaps also Cahuachi on the South coast suggests that ceremonial drinking practices were a crucial aspect of early statecraft in the Andes (Shimada 1994; Castillo et al. 2008; Valdez 1994; Stanish 1994). When the Early Intermediate Period coastal polities collapsed, *chicha* seems to have played a significant role in the formation of the new Middle Horizon centers of Wari and Tiwanaku, which emerged in the highlands, and the integration of smaller polities into these expanding imperial formations (Anderson 2009). P. Goldstein (2003:144) has argued that the growth of the Tiwanaku polity was accompanied by the rapid diffusion of a new assemblage dedicated to maize beer preparation and serving, colonization of maize-producing regions, and a shared identity among ethnic groups. He further proposes that incorporation into the new expansive Tiwanaku state was largely consensual rather than coerced, one principal factor being "the mania for maize beer that took root everywhere Tiwanaku influence was accepted" (ibid.). Similarly, there is archaeological evidence of large-scale and centralized *chicha* production associated with the formation and expansion of the Wari state (Valdez 2006), including both maize *chicha* and *chicha* made from other plants (D. Goldstein et al. 2009). By the Late Intermediate Period, *chicha* was an integral element of Andean

cultures. The Inka thus had a powerful tool, deeply rooted in long-standing and persuasive traditions, which they could build on, modify, and expand to suit their needs (Dillehay 2003:362; Rostworowski 1999).

5.3.2 The role of *chicha* in the Inka political economy

Feasting has long been recognized as the central arena for political relations in the Andes, and *chicha* was arguably the key ingredient in these feasts. From the Early Intermediate Period (dated to around 200 BC to AD 750) and onwards, there is firm evidence of *chicha* production in a number of social settings, including large scale ceremonial feasting (Castillo et al. 2008; Shimada 1994; Prieto 2011; Swenson 2008). One of the principal points established by the research on feasting is that it seems almost universally to be associated with labor mobilization (Dietler 1990; Dietler and Herbich 2001). P. Goldstein (2003:145) sums up the argument as follows: "Characterized by the easy convertibility of surplus grain into drink, drink into public labor, and control of public labor into individual prestige, feasting enables the emergence of social inequality. As wealthier and more powerful corporate groups promote larger and larger feasts, fewer and fewer participants can shoulder the growing burden of sponsorship." In other words, feasting is presented as a self-reinforcing process that leads to greater and greater inequality. It is often remarked how festive celebrations in the Andes reenacted hierarchical relations; an excerpt from Jennings (2014:29) serves to illustrate this point:

> One of the keys to Inca rule was the ability to overwhelm its subjects with the empire's largesse. Building on traditions of reciprocity, the empire hosted feasts to recompense people for their service to the state. Yet, the feast went far beyond the means of local leaders. Excessive drinking was encouraged at these events, and the millions of liters of beer brewed under the auspices of the Inca put his subjects in his debt by the sheer quantity of chicha provided… … Inca subjects could not reciprocate by having the emperor over for a drink. The only way to begin to repay his generosity was to provide more service to the state" (Jennings 2014:29).

The volumes of *chicha* consumed at these Inka feasts are attested in the historical sources. One particularly illustrative eyewitness account comes from Miguel de Estete (1968[1535]) who was among Pizarro's first conquistadores:

> Everybody was placed according to their rank; from eight in the morning until nightfall they were there without leaving the feast, there they ate and drank… The wine they drank was made of roots and maize, like beer, and was enough to get them intoxicated because they are very lightheaded people. There were so many people and so much wine, and both men and women poured so much [wine] into their skins, because they are so good at drinking rather than eating. It is certain without a doubt that two broad drains, more than half a vara wide, went under the paving to the river, which must have been made for cleanliness and to drain the rain which fell in the plaza or by chance, the most certain is for that purpose all day urine ran, from those who urinated in it in such an abundance, it was as if there were fountains issuing from it … to see it was marvelous and a thing never seen before (Estete quoted in Salazar and Burger 2004:347).

Dietler (2001:82-83) has called this kind of feasting "patron-role feasts," which are feasts that involve the "formalized use of commensal hospitality to symbolically reiterate and legitimize institutionalized relations of asymmetrical social power". It is a kind of feast where "equal reciprocation is no longer maintained. Rather, the acceptance of a continually unequal pattern of hospitality symbolically expresses the formalization of unequal relations of status and power and ideologically naturalizes it through repetition of an event that induces sentiment of social debt" (ibid.).

It is well documented that the Inka state periodically hosted enormous feasts serving its guests with liberal amounts of *chicha* at sites such as Huánuco Pampa (Morris and Thompson 1985), and it has been suggested that an important way in which the Inka expressed their new imperial order was through changing feasting practices (Moore 1996). The construction of large plazas was characteristic of Inka imperial architecture. Structures such as the plaza at La Viña on the north coast of Peru, 5.2 hectares in area, are a clear sign of the Inka presence in the region (Hayashida and Guzman 2015). In contrast to feasting practices in some of the coastal polities which the Inka conquered, where feasting appears to have been restricted and exclusive, the Inka constructed very large open plazas which could accommodate large numbers of people. Although food was important at state sponsored feasting events, the "main concern centered on the serving and drinking of large amounts of corn beer" (Bray 2009b:110).

5.3.3 Reciprocity, labor, and *chicha* in the Inka Empire

In the Andes, an important aspect of the reciprocal labor obligation was the understanding that the work party would be fully provisioned by the sponsor (e.g. Murra 1980) in accordance with the principle and notion of *mink'a*. Ideally this was also the case with the labor services which local communities owed to the Inka state, but the extent to which this was always the case, and how the provisioning was organized, is uncertain. Ultimately, the labor and resources came from the communities themselves. In return for their labor service, workers received services from the Inka. The greatest service of them all was the life-sustaining force which the Inka in his capacity of being son of the Sun secured (Godelier 1986). On a more mundane level, items such as textiles, *chicha*, and food were also expected in return for labor. Several accounts by the chroniclers suggest that the loyalty of the Inka army depended upon whether the soldiers received cloth and food, in that order, in return for their service (Murra 1980:76). Historical documents from the north coast of Peru after the European invasion likewise demonstrate the role of *chicha* for labor mobilization. When the colonial authorities tried to ban *chicha*,[40] the local lords testified that:

> Because the Indians do not obey us we cannot finish the communal sowing nor build the community center because it is by the means of chicha that the Indians obey us" (Moore 1989:685, translated from Netherly 1977).

The persuasive capacity of alcohol, *chicha*, and other stimulants in modern-day traditional Andean communities has been compellingly described by Allen (2002[1988]), and Jennings (2014) gives a description of how this would have worked in Inka times:

[40] There were probably many reasons for this. *Chicha* was for instance seen as an important hindrance to conversion to Christianity (Krögel 2015).

> Just as it occurs today, the social order was expressed through drinking. The Inca emperor expressed solidarity with his guests by offering them a drink, and the order in which the drinks were given, the phrase that he or his representative used in offering the drink, the quantity of the drink, and many other factors could be used to signal social ranking. To refuse a drink was unthinkable; it was an act of war that refused to recognize Inca rule. Those that denied the Inca emperor were sometimes turned into keros themselves – their heads severed and transformed into goblets for drinking (Jennings 2014:28-29).

This excerpt is particularly evocative of the interrelationship between consensus and coercion. *Chicha* manifested and maintained a certain social order. Commensal practices, as they are constantly reenacted, are a central arena for negotiation of social hierarchy, and in Inka times they seem to have led towards greater inequality and disparities, not just between the Inka and their subjects, but even at the household level.

5.3.4 Inputs in *chicha* production: maize, pots, fuel, and labor

As with all other socio-ecological processes, determining where *chicha* brewing begins and where it ends is a heuristic exercise, but we may state that the brewing of maize *chicha* in the Andes requires certain inputs such as maize, water, fuel, pots, and other tools.[41] Without these ingredients and the human skill and labor to organize the production process, there would be no *chicha*. In my calculations I have thus included the time and space embodied in the pots and the fuel used in *chicha* production.

The calculations are based on a number of ethnoarchaeological and ethnographic studies on *chicha* brewing, pottery production, and fuel use in the Andes. The archaeological record reveals striking similarities between ancient and modern brewing techniques (Moore 1989; Gero 1990), which suggests that *chicha* has been made in a similar fashion at least since the Early Intermediate Period (Jennings 2005:244). We may assume that ethnographic observations and experiments with *chicha* making yield valid estimates of production requirements in prehispanic contexts. A number of studies have been published on the process of *chicha* brewing (Cutler and Cardenas 1947; Nicholson 1960; Perlov 1979; Moore 1989; Sillar 2000a;

[41] For example sieving cloths and frames, stirrers, etc.

Jennings 2005; Hayashida 2008). The figures on labor and material requirements of pottery are based mainly on Hagstrum's (1989) ethnoarchaeological study from the Mantaro Valley and fuel requirements of firing pottery in Sillar's (2000a) ethnoarchaeological study on Andean pottery. General information on fuel use and management in the Andes has been retrieved mainly from the works of Johannessen and Hastorf (1990), Hastorf et al. (2005), Sillar (2000a), Mayer (2002), and Winterhalder et al. (1974).

Although *chicha* could be made from several plants (e.g. Goldstein and Coleman 2004; Goldstein et al. 2009), maize *chicha* was the most common and most highly esteemed in the Inka Empire. Maize had great religious and ceremonial significance in the Andes and was generally regarded as the highest ranking food item (Murra 1960; Bonavia 2013:222). As Morris (1993) has pointed out, the terraces which were constructed throughout the empire on the orders of the Inka were not aimed at raising food production per se, but rather at growing prestigious food items such as maize. Although maize in itself was seen as a prestigious food and was consumed in other forms, the most elaborate form in which maize could be consumed was *chicha*.

From an archaeological point of view, a significant aspect of *chicha* production is the ceramic pots associated with production, storage, and serving. Fragments of these pots are very often the only material traces that remain of prehistoric *chicha* production. Although pots were obviously used for other things in addition to *chicha*, historical sources report that most household pottery in the Andes was intended and used for *chicha* (Cobo 1990[1653]:194).[42] Archaeological studies have indicated a growth in the presence of ceramic forms associated with the Inka *chicha* economy (the *kero* and *aríbalo*), a growth that suggests that the practices in which they were used increased over time (Dillehay 2003:360; Bray 2003; Costin and Hagstrum 1995). Dillehay further writes that the increased emphasis on *chicha* changed local pottery practices from artisanal to almost industrial production (Dillehay 2003:360).

[42] Cobo (1990:194) writes: "To make this beverage, store it, and drink it, they have more instruments and containers than they have for their meals. They use earthen jars; the largest ones contain from four to six *arrobas* (approx. 61 to 91 liters), and the others contain less. They use a large number of jars, both large and small, and three or four different kinds of cups and tumblers."

As modern ethnoarchaeological studies from the Mantaro Valley have shown that the technology of pottery manufacture has changed little over the past 700 years (Hagstrum 1989:138), it is reasonable to assume that labor requirements were approximately the same in pre-historic times as they are today. In her study, Hagstrum finds that there are in fact "remarkable similarities in the production of cooking *ollas* and liquid containing *porongos*" (Hagstrum 1989:4). These two ceramic forms are central among those used for *chicha* brewing; the *ollas* for cooking and the *porongos* for transport, serving, and storage (Hagstrum 1989:23). Pottery production in this area remained the same through Inka and colonial and modern times with the exception of the kiln, which was a Spanish introduction (Hagstrum 1989:99). Prehistorically, pottery was most likely fired in open pits using camelid dung as fuel (Hagstrum 1989:173; Sillar 2000a:63-65).

In addition to fuel for firing the pottery, *chicha* production also required fuel for cooking. In the Andes, a wide range of substances have been used as fuel, in modern times as well as prehistorically (Johannessen and Hastorf 1990). During the Inka period, tree cultivation was practiced to secure firewood, and by-products from agriculture and herds were also used. Animal dung was a particularly valuable source of fuel in the treeless highlands, and Johannessen and Hastorf (1990:68) report that, next to wood, dung was the preferred traditional fuel in the Jauja region in Peru. Curiously, not much has been written about wood use in the prehispanic Andes, but research shows that a large number of species were used in both Inka and pre-Inka times (Hastorf et al. 2005). The Inka state collected large quantities of wood in tribute for both mundane and ceremonial purposes, and as some of the species found in the Mantaro Valley grow only on the humid eastern slopes of the Andes, it is likely that wood was imported (Johannessen and Hastorf 1990:83). The Inka state also kept wood plantations and strictly controlled access to wood and forests (Hastorf et al. 2005:338).

Today the Pacific coastline of the Inka Empire is largely desert, but previously, these areas were probably to a much larger degree covered in *algarrobo/huarango* forest. *Algarrobos/huarangos* are leguminous trees belonging to the species *Prosopis pallida/juliflora* (Pasizcnik et al. 2001; Beresford-Jones et al. 2009).[43] These trees can grow as old as one thousand

[43] The terminology used to describe these characteristic trees growing in the arid Pacific coastal regions of South America is rather confused, even in the archaeological literature.

years, and since they have very deep root systems can reach groundlevel water tables and thrive even in areas with close to zero precipitation. The crucial role of the *algarrobos/huarangos* to the coastal environment, climatic conditions, and soil fertility is only beginning to be recognized, and the coastal *algarrobo* forests were probably a precondition for Andean coastal agriculture and civilizations (Beresford-Jones et al. 2009). In the years following the European invasion, these forests were rapidly depleted, but even before the arrival of the Europeans, they were diminishing in some areas, partly because of human activity (ibid.).

Labor is another essential input in *chicha* making. Abercrombie (1998:362-363) describes *chicha* as a drink "extremely time-consuming to make," and *chicha* brewing as an "enormously labor-intensive process," and most scholars agree that *chicha* production in the Inka Empire was practiced on such a scale that it would have put severe strains on the everyday lives of the people producing it (Jennings 2005; Costin 2015). Some important steps in the process of producing *chicha* are not included in the calculations, such as the collection of water, the malting/germinating process of soaking the maize, mounding and leaving it to germinate, drying maize afterwards, and serving the *chicha*. The reason why these elements have been left out is not because they are insignificant, but because I have not been able to find information to base calculations on.

5.3.5 The process of *chicha* brewing

The brewing process itself includes malting or salivating, grinding, cooking, working/sieving, and fermenting. After the maize has been harvested and before beginning the actual brewing, the maize needs to be dried, shelled, selected, and ground. The maize also needs to be prepared in order to start the chemical process of turning starch into sugar, which increases the alcoholic content of the *chicha*.

There are two main methods to start the breakdown of starch into sugar, both of which were apparently used prehistorically: germination and

---

On the north Peruvian coast they are known as *algarrobo*, while on the south coast they are called *huarango*. For more information see Beresford-Jones et al. (2009).

mastication/salivation.[44] Germination, or malting, is done by soaking the maize kernels in water and leaving them to germinate. The germination produces amylase for starch conversion. The second way to prepare maize is to masticate, that is chew, or mix the ground maize with saliva by working it with the tongue. The salivated morsels of maize, *muku*,[45] can then be dried and stored until they are to be used. The human saliva contains enzymes which start the starch conversion. This method is described by the chroniclers and it seems to have been preferred by the Inka. The chroniclers report that women, especially the *aqlla*, carried out this task.

In modern times malting or germination is by far the most common method of preparing maize for *chicha*, but salivation is often mentioned as the common method during Inka times (J. Rowe 1946:292).[46] The chroniclers describe both salivation and germination (Bonavia 2013) and both methods were most probably used prehistorically. Some plant parts used for making *chicha* also needed to be chewed, because they were not suited to grind using traditional Andean techniques, for instance the fruit pods of the *algarrobo/huarango* tree (Cutler and Cárdenas 1947). Mastication then served both the purpose of grinding and salivating, but Cutler and Cárdenas (1947:41) state that maize was ground with a traditional stone grinder (*maran*) before it was salivated.

Cultural preferences probably largely determined which method was used, and *muku* chewed by the *aqlla* for instance no doubt added significantly to the value of the *chicha* made from it during Inka times. The Spaniards, on the other hand, were repulsed by the idea of beer produced by salivation.[47] There may also have been more practical reasons for using the method of salivation/mastication. The success of the malting/germination method is to a much larger degree dependent on environmental and weather conditions and

---

[44] Most sources seem to equate the two terms of mastication and salivation, but Cutler and Cardenas (1947:41) suggest they were two different techniques.

[45] *Muku* are morsels of salivated maize.

[46] Cobo, Zárate (1968[1555]), Guaman Poma as well as other early writers mention *chicha* made from chewed maize. Acosta refers to both the germination method and the mastication/salivation method and Garcilaso only mentions the germination method (Bonavia 2013; Krögel 2015).

[47] See Krögel (2015) for a discussion on food (*chicha*) and identity politics in Tawantinsuyu and colonial Peru.

can be quite difficult to carry out during the rainy season (Nicholson 1960:297). Salivated maize morsels are ready to use immediately, while the germination process requires at least two weeks of preparation before the *chicha* can be brewed. Also, ground *pachucho*[48] will keep for only 4 to 6 weeks (Nicholson 1960:296; Hayashida 2008), while the dried *muku* morsels could be stored for longer periods of time. Considering the crucial importance of storage in Inka political economy (D'Altroy and Earle 1985; Morris and Thompson 1985; Morris 1986; LeVine 1992), this could have been of great practical importance.

After completion of the preparation process, either by grinding and mastication or by malting and grinding, the cooking and brewing can begin. The maize, now either in the form of malted and ground *jora*[49] or ground and masticated/salivated morsels, is poured into a cooking vessel together with water and cooked at relatively low temperatures between 7 and 15 hours. During the cooking process, which may typically take between three and four days, the *chicha* is alternately heated and cooled, transferred to other vessels, and "worked" as the dregs of maize are retrieved from the liquid and crushed and sieved through some form of frame back into the *chicha* vessel. After finishing the cooking and working/sieving processes, the *chicha* is often transferred into a larger storage vessel and left to ferment. Depending on environment and altitude, the *chicha* will start to ferment and be ready for consumption in between one and six days, but most often after three to four days. It then needs to be consumed within a week, as it will quickly sour and turn into vinegar. Depending on method of production, the whole process from malting to finished *chicha* is estimated to last between two and four weeks (Sillar 2000a).

Most of the research on feasting and *chicha* production in the Inka Empire has focused on the large-scale public feasting ceremonies staged by the Inka at centers such as Huánuco Pampa (e.g. Morris 1982; Morris and Thompson 1985) and work-party *chicha* consumption. P. Goldstein (2003:148), however, reminds us that the large-scale feasting was just "the tip of the iceberg when we consider the society-wide transformative effect of feasting and imbibing." He suggests that *chicha* ceremonies were far more pervasive

---

[48] *Pachucho* generally refers to ground malted maize.

[49] Before being ground or milled, malted/germinated maize is often referred to as *jora* (Moore 1989).

and that microcosms of Inka feasting ceremonies were enacted in local and even household contexts. From studies in the Mantaro Valley we also know that Inka rule directly or indirectly imposed a greater labor demand on household *chicha* production (Hastorf 1990). It therefore seems reasonable to consider two examples of possible prehistoric production contexts: one of large-scale Inka ceremonial feasting, and one of smaller-scale household *chicha* production.

In more recent times, one of the differences between *chicha* brewed for daily household consumption and *chicha* brewed for feasting is the thickness of the brew. Thicker brews are typically made for household consumption and serve as both meal and drink for people who have worked in the fields, while the thinner brews are more common at feasts. One of the reasons for this is that at parties the aim is getting drunk, which means that very large amounts of *chicha* are being downed, so the brews should not be too filling (Jennings 2005:246). Accordingly, the estimates for the ratio of maize (kg) per unit of *chicha* (liter) vary quite significantly between different sources. Jennings (2005:246-247) reports figures that range between a 1:1 and 1:7 ratio, and he suspects that the amount of maize used to make *chicha* for prehispanic feasts was probably somewhere between these two figures. Hayashida (2008:168,170-171) reports significantly lower maize inputs per *chicha* yield, as low as 1:25, but such low maize ratios are found in untraditional brewing contexts, where other ingredients are added such as sugar. Therefore I use the ratios proposed by Jennings and assume a ratio of 1:1 in brews for household consumption, and a ratio of 1:7 in brews for feasting.

In Example 5.3.1 I assume that the *chicha* was made with malted maize kernels. In Example 5.3.2, which should refer to an Inka feasting context, the information provided by the chroniclers suggests that the maize was prepared through the mastication/salivation method by the *aqlla*. Based on ethnographic documentation, Jennings (2005:247-8) suggests that typical figures of daily *chicha* consumption in the Andean past was between two and three liters, and at feasts the average consumption per person was a high as 12 liters per person.

Example 5.3.1: Small-scale household chicha production

In this first example I use the information given by Cobo. Cobo travelled in the Andes in the early 1600s and wrote about the customs and daily lives of

native Andeans.[50] Cobo (1990:194) wrote that people usually made *chicha* in batches of four to six *arrobas*[51] (approximately 61 to 91 liters) at a time, which lasted "a man" or a household around a week. I also assume that the *chicha* made for household consumption required 1 kg of maize per liter *chicha,* and was made year-round on a weekly basis, which means that the weekly maize requirement would be 76 kg (i.e. the average of 61 and 91) and annual maize requirements 76 kg × 52 weeks = 3,952 kg. Finally I assume that the *chicha* has been cooked in five 15 liter *ollas*, and fermented and stored in three 28 liter *porongos.*[52]

---

[50] Father Bernabe Cobo did not arrive in Peru until 1599 and he first travelled to Cuzco in 1609, that is almost 80 years after the European invasion (Cobo 1990[1653]:xi).

[51] *Arroba* was a measuring unit for weight and volume in Spain and Portugal, a Spanish *arroba* was approximately 11.5 kg and 15 kg in Portugal. Also today, the definition of an *arroba* varies. Four to six *arrobas* is stated in the translation by Roland Hamilton of Cobo's (1990:194) text to be equivalent to sixteen to twenty-four gallons, or 61 to 91 liters and I will follow this definition.

[52] In practice, *chicha* brewing would probably normally require more ceramic pots, jars, cups, and tumblers than those included in this example in order to carry water, to work the *chicha* in, etc. The reason I have chosen to include five *ollas* and three *porongos* in this example is that their volume requirements fit reasonably well with the volume requirements of the batch (76 liters), and that studies have been made on the labor and material requirements of such pots (Hagstrum 1989).

Table 5.3.1
Ecological space (ha) and labor time (hours) embodied in *chicha* household production.

Space (ha)	Per year/household
Maize[a]	2.7 ha (agricultural land)
Fuel **for cooking *chicha***[b] **for firing pots**[c]	 13 ha (pampa pasture) 0.1 ha (pampa pasture)
Total	15.8 ha
Time (hours)	
Planting/harvesting maize[d]	2,124 hours
Pottery production[e]	5 hours
Fuel collection[f]	180 hours
Shelling maize[g]	226 hours
Malting (selecting, soaking, leaving to germinate, drying)[h]	-
Grinding[i]	1,884 hours
Cooking[j]	564 hours
Working/sieving[k]	218 hours
Total	5,201 hours

Notes to Table 5.3.1

a. Maize: Nola Reinhardt's study on farming in the Colombian Andes, where maize farming was carried out under fairly traditional circumstances and mostly without chemical fertilizers and pesticides, showed annual maize yields per hectare ranging between 1,200 and 1,700 kg (Reinhardt 1988:248-253), which gives an average of 1,450 kg/ha. Jennings (2005:249) by comparing other figures from Peru and Bolivia arrives at almost the exact same estimate of 1,456 kg. I will use the average of 1450 kg/ha.[53] Assuming that 1 kg of maize is required to produce one liter of thick *chicha*,[54] and that the annual *chicha* production was 52 weekly batches of 76 liters, the annual

[53] Hastorf (1993: 237, Appendix C) has reported significantly lower estimates of prehispanic maize yield per hectare in the different land-use zones in the Mantaro Valley. Since this area is not optimal for maize cultivation, I will use the higher figures. It should be kept in mind, however, that the area available for maize production in the Andes was limited and that maize production outside of the optimal zones would have yielded less per unit of input of labor and land.

[54] As an estimated 10 percent of the weight of the maize is lost in the malting process (Hayashida 2008:163), the actual input of maize in the *chicha* is 0.9 kg per liter.

maize requirement per household would be 52 × 76 = 3,952 kg, which would require 3,952 / 1,450 = 2.7 ha.

b. Fuel for cooking *chicha*: Hayashida (2008) provides figures on the use of firewood for *chicha* production on the north coast of Peru. She estimates that the mean fuel consumption per *lata* (that is per 19 liters) is 9.22 kg of wood. Hayashida (2008:169) reports that on the north coast of Peru, the favored fuel source for making *chicha* was *algarrobo/huarango*, which, as mentioned, is a native and drought-tolerant tree species that grows along the desert coast of Peru. In a highland context, where wood was scarce, the main fuel source was llama dung (Winterhalder et al. 1974). Based on the figure arrived at by Hayashida (2008:169) on average fuel requirement per *lata* of *chicha* (9.22 kg) it is possible to arrive at a similar estimate of llama dung requirements for the same amount of *chicha*. Animal dung and its heating properties vary according to species, diet, age, and health (Sillar 2000a:63), but the heating value of dried dung ranges between 50 percent and 100 percent of the caloric value of wood (Vankat et al. 2010). Winterhalder et al. (1974:99) report from their study on fuel use from the Peruvian highlands that a dung fire required 15.4 kg of material and a wood fire 11 kg over a three-hour period. If we use this ratio of 11 / 15.4 ≈ 0.71, the heat supplied by 1 kg of wood can be replaced by 100 / 71 × 1 kg = 1.4 kg of dry dung. The requirement to provide the same heat as 9.22 kg of wood would then be 9.22 kg × 1.4 kg = 12.9 kg of llama dung. Winterhalder et al. (1974:96, Table IV) also report that llamas drop 1 kg of dung (dry matter) every day, or 365 kg annually. The spatial requirements of a llama are 1.75 hectares of pampa pasture (Kuznar 1991b:337), and the annual production of dried dung per hectare would be 365 kg / 1.75 ha = 209 kg/ha.

Since our batch of 76 liters is exactly the equivalent of 4 *latas* we assume that a reasonable estimate of llama dung requirements for the 76 liter batch would be 4 × 12.9 kg ≈ 52 kg of dried llama dung. Over a year, 52 weekly batches would then require 2,704 kg, which would require a pasture area of 2,704 / 209 = 13 ha.

c. Fuel for firing pots: Sillar (2000a:177, Appendix 3) describes the firing of 94 pots in the Bolivian highlands. The firing is done with animal dung (sheep, cow, and llama) in an open pit fire, with the pots stacked, the smaller ones inside the larger, as was probably also done in prehispanic times (Hagstrum 1989:173; Sillar 2000a:63-65). The total volume of the 94 pots of varying size and shape described by Sillar (2000a:177) is 2,490 liters or 2.49

m^3, and 40 loads of dung are used for fuel. Unfortunately, Sillar provides no further description of the load than it "being as much as a person can carry." As I have defined a standard for carrying load to be 20 kg (see introduction to case studies), the fuel requirements per liter of pot volume was 40 × 20 kg / 2,490 liters = 0.32 kg of animal dung. Since the total volume of the cooking pots required in Example 5.3.1 is 15 × 5 = 75 liters and the assumed average lifespan of the pots is two years, the annual dung requirements would be 75 liters × 0.32 kg / 2 = 12 kg. If each batch of *chicha* requires 3 *porongos* (28 liter each) for fermentation and these have an average lifespan of 5 years,[55] the annual dung requirements would be 28 × 3 × 0.32 / 5 = 5.4 kg of dung. In total, the annual requirements of pottery firing would be 12 + 5.4 = 17.4 kg of dung, which would require 17.4 / 209 = 0.1 ha of pasture land.

d. Planting/harvesting maize: Labor requirements for maize have been studied in modern times. Reinhardt's (1988) study on farming in the Colombian Andes, where maize farming was carried out under traditional circumstances and mostly without chemical fertilizers and pesticides, showed that the labor requirements were quite low, ranging between 20 to 53 man-days per hectare (Reinhardt 1988:248-253). Brush (1977:96, Table 7) calculates the labor requirements of maize (and red kidney beans, which are grown together with maize) to be 92.8 man-days per hectare. Hastorf (1993:128, Table 6) estimates 105 labor days per hectare. Zimmerer's (1991:422) study on labor requirements of maize in the southern Peruvian Sierra suggests 121 labor days per hectare. The variation in these figures on labor input in maize production probably to some extent reflects different methodologies, but also the real variation in agricultural production in different geographical and historical settings. Although the estimates are based on studies of traditional agricultural practices, resembling prehispanic ones, peasants in Tawantinsuyu did not, for instance, use draught animals to work the land.[56] Assuming this added to the labor time in prehispanic times, I

---

[55] The average life-span of a *porongo* in the modern Mantaro Valley may be as much as 10 years, according to Hagstrum (1989:284). However, this figure is very likely inflated relative to what it was traditionally. The pattern of *porongo* consumption has changed dramatically because of the use of piped water and other containers for liquid, e.g. plastic buckets (Hagstrum 1989:289-290), which means *porongos* today are not exposed to the same level of wear and tear as was the case in prehispanic times. The usage patterns for cooking *ollas* has not changed in the same manner.

[56] Traditionally, in the highlands, soil was broken with the *taqlla*, the foot plow, while on the coast a shovel called *llampa* was used for the same purpose (Rostworowski 1999:193).

will use the higher estimate provided by Zimmerer of 121 labor days per hectare maize. The calculations in Table 5.3.1 show that the annual spatial requirements of *chicha* amounted to 2.7 ha, which means that the labor requirements were 2.7 × 121 days of labor × 6.5 hours = 2,124 hours.

e. Pottery production: The figures Hagstrum gives for the absolute time invested in the manufacture of a large (15 liter) *olla* is 98 minutes (Hagstrum 1989:469-472, Appendix G.1). Included in the calculation is the time required per *olla* to procure the clay and pigments as well as the fuel, the coiling of the pot itself, rasping, handles, finishing, polishing, decoration, and firing. As prehispanic Wanka pottery was not rasped (Hagstrum 1989:261), I will subtract the time requirement of rasping (10 minutes per *olla*) from the total figure of 98 minutes = 88 minutes. To make a batch of 76 liters would require approximately 5 cooking *ollas* each containing 15 liters. This means 5 × 88 = 440 minutes. Since the life time of *ollas* is estimated at 2 years, the annual labor requirement would be 440 / 2 = 220 minutes. The same calculation for three 28 liter *porongos* implies that they each required 144 minutes. Subtracting the 12 minutes required for rasping (as rasping was not done on prehispanic pots) the labor requirements for the *porongos* were 3 × 132 = 396 minutes. Assuming the average life-span of a *porongo* was 5 years, the annual labor requirements to produce *porongos* for the weekly batch of *chicha* in our example were 396 / 5 = 79 minutes. The total pottery requirements were thus 220 + 79 = 299 minutes ≈ 5 hours.

f. Fuel collection: Since the fuel requirements for firing the ceramics are included in Hagstrum's (1989) study, fuel collection here only refers to the fuel required to cook the *chicha*. If we assume that 15 kg of dung could be collected in one hour (see e.g. Sillar 2000a, 2000b; Johannessen and Hastorf 1990; Winterhalder et al. 1974), the labor requirement per kg of dung is 0.067 hours. As the annual requirements were 2,704 kg (see note b), the labor time can be estimated as 2,704 / 15 = 180 hours.

g. Shelling maize: Figures on shelling are obtained from a FAO report which states that traditional shelling by hand is tedious labor, which results in 10-25 kg of maize per hour (FAO 2003:55). I use the average figure of 17.5 kg/hour. Removing the kernels required to produce 52 (one for every week of the year) batches of 76 liters of *chicha* therefore requires 52 × 76 / 17.5 kg = 226 hours.

h. Malting (selecting, soaking, leaving to germinate, drying): Although the malting or germination process is time consuming it is difficult to quantify, and it has therefore been left out of the calculations. These production tasks would nevertheless make a significant contribution to the total labor embodied in *chicha*. The estimate of total labor time in Table 5.3.1 should therefore be considered conservative**.**

i. Grinding: Hayashida (2008:163) reports that an estimated 10 percent of weight is lost during the malting process, and Nicholson (1960:296) reports a 10-15 percent loss of weight between maize and *pachucho*. I have calculated a loss of 10 percent in my examples, which means that if we assume the original input of maize in a thick *chicha* brew is 1 kg, after the process of malting, 0.9 kg of *pachucho* remain. Based on experimental research, Hayashida (2008:169) estimates that it takes 31.8 minutes to grind 1 kg of maize on a traditional Andean stone grinder (*maran*), which means that grinding 0.9 kg of *jora* would take 31.8 × 0.9 ≈ 28.6 minutes. The time required for a whole batch would be 76 × 28.6 = 2,174 minutes = 36.2 hours and annually 52 × 36.2 = 1,884 hours.

j. Cooking: For cooking time requirements, I have used figures from Hayashida (2008:170, Table 2). The mean cooking time for one *lata* (one *lata* = 19 liters) was 2.71 hours. Since the batch size in my example is 76 liters or exactly 4 *latas*, the labor requirements per batch were 4 × 2.71 = 10.84 hours and per year 52 × 10.84 = 564 hours.

k. Working/sieving: I have used figures from Hayashida (2008:170 Table 2) on the labor time of working/sieving per *lata* (19 liters). Since the ratio of maize per liter *chicha* is very high in this example and the amount of maize meal to work per liter of *chicha* was therefore correspondingly high, I use the maximum value in Hayashida's Table 2 which is 1.05 hours per *lata*.

Since the batch size is 4 *latas* (76 liters), the labor requirements for working/sieving were 4 × 1.05 hours = 4.2 hours per batch and 52 × 4.2 = 218 hours per year.

Example 5.3.2 Inka large-scale ceremonial feasting

In Table 5.3.2 the calculations are based on the case of an Inka feast serving 500 people with 12 liters of *chicha* each, or 6,000 liters in total. I am assuming that a batch of this size was made weekly, and that the production pots were in continuous use. Such a scenario would have been likely in the

aqllawasi, for instance, where the *aqlla* worked full-time for the Inka state primarily producing textiles and *chicha*. The input of maize per liter of *chicha* is estimated at a ratio of 1:7, i.e. one kg of maize yielded seven liters of *chicha*.

Table 5.3.2
Ecological space (ha) and labor time (hours) embodied in *chicha* brewed for Inka ceremonial feasting.

Space	Per batch (6,000 liters)
Maize[a]	0.59 ha (agricultural land)
Fuel **-for cooking *chicha***[b] **-for firing pots**[c]	 0.9 ha (forest) 0.16 ha (pasture)
Total	1.65 ha
Time (hours)	
Planting/harvesting maize[d]	464 hours
Pottery[e]	12 hours
Fuel collection[f]	194 hours
Removing kernels/shelling[g]	49 hours
Grinding maize[h]	454 hours
Salivating[i]	3,214 hours
Cooking[j]	69 hours
Working/sieving[k]	186 hours
Total	4,642 hours

Notes to Table 5.3.2

a. Maize: To estimate the labor requirements of maize, I use the same figures and method as in Table 5.3.1 (see above). Assuming that 1 kg of maize is required to produce 7 liters of *chicha,* the spatial requirements per batch would then be 6,000 / 7 / 1,450 ≈ 0.59 ha.

b. Fuel for cooking *chicha*: We may assume that the *chicha* for the feasting context was made with imported wood from the montane forests on the eastern Andean slopes (e.g. Hastorf et al. 2005). In order to assess the spatial requirements, a value for the net primary production of such a forest is needed, that is, the annual increase in biomass that could be sustained over time. One such study has recently been published with the purpose of establishing the carbon cycling of tropical montane cloud forests in the

Kosñipata Valley, 60 km northeast of Cuzco (Girardin et al. 2014). By dividing the values for carbon production arrived at by Girardin et al. (2014:113, Table 4), which are given in Mg C ha^{-1} $year^{-1}$ (that is in tons of carbon per hectare per year), with the value used by the same authors (Girardin et al. 2014:112, Table 3) to convert biomass into carbon, I can estimate values for net primary production in metric units. Net primary production of above ground coarse wood per hectare in two separate plots in the Kosñipata Valley was (1.50 + 1.20 + 0.15 + 0.15) / 2 = 1.5 Mg C ha^{-1} $year^{-1}$. On average, carbon was 47.3 percent of the biomass, so the production of biomass (wood) was 1.5 / 0.473 = 3.17 tons/ha/year.

If we use the values for how much fuel is required per liter *chicha* (9.22 kg per *lata*, which is 19 liters) arrived at by Hayashida (2008), the production of a large batch (6,000 litres) of *chicha* for feasting would require 9.22 × 6,000 / 19 = 2,912 kg of firewood. As we have seen, the annual net wood production per ha of montane forest is 3.17 tons. The requirements of fuel for cooking 6,000 liters of *chicha* was thus 2,912 kg / 3,170 kg = 0.9 ha.[57]

c. Fuel for firing pots: There is reason to believe that dung was the preferred fuel used for firing ceramics in prehistoric times (Sillar 2000a:63). I have calculated above (Table 5.3.1, note c) the dung requirements to be 0.32 kg of dung per liter pot volume. Since a batch of 6,000 liters would require cooking pots and fermentation/storing/serving jars, the pot volume would be at least 2 × 6,000 = 12,000 liters. Assuming that the average lifespan of a cooking pot (*olla*) was two years and that each batch required the cooking pot for one week, then each pot could be used two years × 52 times/year = 104 times continuously during its lifetime. The fuel requirements per batch for firing cooking pots would be 0.32 kg × 6,000 / 104 = 18.5 kg of dung. For the fermentation and serving pots (the *porongos*), we assume an average lifespan

[57] For comparison, we may take another example from the coastal *algarrobo/huarango* forests. Pasiecznik et al. (2001:84) gives figures of biomass production ranging between 2-8 t/ha/year for this tree species (it should be noted, however, that measures vary dramatically in different geographic locations). The production figures given by Pasiecznik et al. are based on a 5-10 year rotation system, as would be expected for fuelwood harvesting. However, *algarrobo/huarango* (Prosopis *pallida/juliflora)* trees can grow as old as one thousand years, and after 10-20 years yield very large quantities of fruit pods (Pasiecznik et al. 2001:5, 92). These pods were an invaluable source of human food, animal fodder, and fuel in prehistoric times (Pasiecznik et al. 2001). If we use an average of the values given by Pasiecznik et al. (2001:84) and assume a yield of 5 tons per hectare per year, then the requirements to produce 6,000 liters of *chicha* would be 2,912 kg / 5,000 kg ≈ 0.6 ha of *algarrobo/huarango* forest plantation.

of five years and that the pots were in use for two weeks for every batch. Each pot could then be used five years × 26 times/year = 130 times and the fuel requirements per batch for firing *porongos* are 0.32 kg × 6,000/130 = 14.8 kg dung. Thus, the total fuel requirements for firing ceramics are 18.5 + 14.8 = 33.3 kg dung per batch. With 6,000 l of cooking pots and 12,000 l of fermentation/serving pots in continuous operation, one batch could be produced every week, that is, 52 batches per year, implying that the annual dung requirement would be 52 × 33.3 = 1,732 kg. As the annual production of dried dung per hectare was calculated to be 209 kg (see Table 5.3.1, note b), the area requirement would be 1,732 / 209 = 8.3 ha per year or 8.3 / 52 = 0.16 ha per batch.

d. Planting and harvesting maize: As in Example 5.3.1, I will use the value arrived at by Zimmerer (1991) of 121 days of labor per hectare maize. As the requirements of maize have been calculated to be 0.59 ha per batch, the labor requirements would be 121 days × 6.5 hours × 0.59 ha = 464 hours per batch.

e. Pottery production: It is reasonable to assume that *chicha* brewed for ceremonial feasting was sometimes made with larger pots than the *chicha* brewed for household consumption. However, there is historical evidence that locally manufactured *ollas* were exported to administrative and feasting centers such as Huánuco Pampa (LeVine 1987), most likely to be used primarily for *chicha* brewing. In prehistoric times, pot sizes were also limited by ceramic technology and by people's ability to lift and transport the pots (Jennings 2005:251). I will therefore assume that the 6,000 liter batch was cooked in 15 liter pots with a life-span of two years, the labor requirements for which we know from Hagstrum's (1989) ethnoarchaeological study, i.e. 88 minutes (see note for ceramics in Table 5.3.1). Using the same context for calculation as described above in note c, the labor requirements to produce the cooking pots were therefore 6,000 / 15 × 88 / 104 = 338 min = 5.6 hours per batch.

The second category of ceramics crucial for Inka feasting was the so-called aryballoid jars, which were used to store, transport, and serve *chicha*. The *porongos* studied by Hagstrum (1989) are similar in shape and technique to the Inka *aríbalos*, but the Inka ware was much more elaborate and labor intensive. Although Hagstrum unfortunately does not give any estimate of the absolute labor requirements of Inka *aríbalos*, she sets up a production task index for archaeological wares (Hagstrum 1989:259-260, Table 6.7; see also Costin and Hagstrum 1995). By comparing the figures on the modern

porongo and the prehistoric Inka ware, I arrive at a plausible potential ratio of the difference in labor investment between common and Inka wares. After subtracting the labor requirement of resource procurement (clay, fuel, etc.), and materials preparation for *porongo* production, which was 48 minutes, a modern *porongo* requires 96 minutes of labor time and reaches an index score of 47 (Hagstrum 1989:257). The Inka aryballoid "*porongo*" has a score of 85 (Hagstrum 1989:260). The ratio between the two wares is then 85/47 = 1.81. The labor requirements to produce one Inka aryballoid jar containing 28 liters can then be estimated at 96 × 1.81 + 48 minutes of materials procurement and preparation = 222 minutes. Using the same context for calculation as described above in note c, the labor requirements for the Inka *aríbalos* can be calculated as 6,000 / 28 × 222 / 130 = 366 minutes = 6.1 hours per batch.

The total labor time for the pottery is then 5.6 + 6.1 ≈ 12 hours.

f. Fuel collection: As in Example 5.3.1, the labor requirements for collecting the fuel for firing pottery is included in the estimate of pottery labor, so the fuel here refers only to the requirements for cooking the *chicha*. In note b we see that cooking 6,000 liters of *chicha* required 2,912 kg of firewood. Estimating the labor requirements for collecting this firewood will here be based on educated guesswork: It is known that wood was collected as tribute by the Inka state (Hastorf et al. 2005:338), and the Inka kept plantations (*moyas*) for wood production. Also, archaeological and ethnographic studies in the Mantaro Valley have shown that fuel management strategies in certain respects have continued since prehispanic times (Johannessen and Hastorf 1990). The ethnographic information suggests that firewood is cut once a year, during the span of a few days, and stored (Johannessen and Hastorf 1990:69). This fuel source, however, needs to be augmented by daily or weekly collection of shrubby woods and other fuel types, and in Inka times the wood would also have had to be transported to the *chicha* production site. It seems reasonable to assume that the labor requirements to obtain wood would have been similar to those of obtaining dung, or 15 kg of fuel per hour (compare note f, Table 5.3.1). The labor requirements of obtaining 2,912 kg of firewood can thus be estimated as 2,912kg / 15 hours = 194 hours.

g. Shelling maize: For shelling maize I use the average figure of 17.5 kg/hour (see Notes to Table 5.3.1, note g). To make 6,000 liters of *chicha* required 6,000 / 7 = 857 kg of maize. Labor time requirements of shelling 857 kg of maize was 857 / 17.5 hours = 49 hours.

h. Grinding maize: I here again use Hayashida's (2008:169) estimates for grinding maize on a traditional Andean stone grinder (*maran*). To grind 1 kg of maize requires 31.8 minutes or 0.53 hours. To grind 857 kg of maize then requires 857 × 0.53 hours = 454 hours.

i. Salivating: The historical information in the chronicles implies that salivation was the method preferred by the Inka to make *chicha*. The chewed maize may be put directly in the pot, but the salivated maize morsels could also be made into *muku*, dried and stored for long periods of time, and ready to make into *chicha* on demand. Although not common, *muku* is still made in the Andes, and the procedure is to take a small handful of ground maize (20 g), put it in the mouth and work it with the tongue into a more compact mass, a procedure which takes around five minutes (personal communication, Sarah Kollnig 2016). Based on the premise that seven liters of *chicha* required 1 kg of maize and reckoning with a loss of 10 percent of maize in the process from harvest to grinding, the labor requirements of salivating maize to produce a batch of 6,000 liters of *chicha* would require 6,000 / 7 × 900 g / 20 g × 5 minutes / 60 minutes = 3,214 hours.

j. Cooking: Hayashida (2008:170, Table 2) found the average cooking time to be 2.71 person hours per *lata*, but also a clear correspondence between batch size and person hours for cooking; that is, the larger the batch, the lower the labor requirements per unit of output (*chicha*). The reason for this is that, regardless of the batch size, only one person tends the simmering *chicha* (Hayashida 2008:170). Although we must assume that more than one person tended the *chicha* pots for large-scale feasting, it is reasonable to assume that labor requirements were lower per unit output. I have therefore used the lowest labor input recorded by Hayashida (2008:170, Table 2) which was 0.22 hours per *lata*. The labor hours required to cook 6,000 liters were then 6,000 / 19 × 0.22 hours = 69 hours.

k. Working/sieving: I have used figures from Hayashida (2008:170, Table 2) on the average mean time of working/sieving per *lata*, which is 0.59 hours. Since the batch size is 6,000 liters or 6,000 / 19 ≈ 316 *latas*, the labor requirements for working/sieving were 316 × 0.59 hours = 186 hours per batch.

5.3.6 Who made the chicha?

We have already seen how *chicha* played a central role in labor mobilization and thus in the imperial metabolism of the Inka Empire. The figures in Table 5.3.1 and Table 5.3.2 should give us an idea of the material dimensions of the "*chicha* economy."

When the Inka informants described their economy to the Spanish chroniclers they stressed that *mit'a* laborers were always provided for by the state with food, drink, tools, and other requirements during the labor period. It is less clear how exactly this "redistribution" was organized, and undoubtedly it varied throughout the historical and geographical span of the Inka Empire. One way or the other, most if not all labor required to support the *mit'a* workers came from the communities themselves, or some of the other categories of Inka subjects. Murra (1982) finds evidence in historical documents that the *mit'a* laborers who were sent away from their home communities on labor duty were accompanied by an equal number of people who cared for their daily sustenance. Likewise, historical evidence recorded in early colonial times from people who had lived during Inka times suggests that the communities supported the *aqllawasi*, bringing "gifts" of food on a regular basis (ibid.).

Ceremonial feasting was undoubtedly an important way in which the Inka state secured the compliance of its labor force, but the frequency of such feasting events is unclear. We see in Table 5.3.2 that it required 4,642 labor hours to make *chicha* for 500 guests. If we assume that the main form of "compensation" that the *mit'a* laborers received for their service to the state was a monthly feast with *chicha* brewed by the *aqlla*, then securing the labor of 500 *mit'a* laborers for 30 days, 6.5 hours a day required 4,642 hours. In other words, 4,642 hours of *chicha* labor secured the Empire 97,500 hours of *mit'a* labor. Through *chicha,* the Inka state could thus appropriate more than twenty times the labor that the production of the *chicha* required. One of the sources of this incredible value enhancement was probably that some of it was produced by the *aqlla.* Garcilaso writes that these women were so holy that the emperor himself received the products of their hands as sacred things, as "the Greeks and Romans would have done if the goddesses Juno, Venus and Pallas had made them" (Garcilaso quoted in Weismantel 2009:268-269). The added value of the *chicha* thus did not derive from the amount of labor

time per se, but from the particular kind of labor which it was perceived to represent and from the social identity of the laborers.

The historical sources report that the most prestigious and highly valued *chicha* in Tawantinsuyu was made by the *aqlla*. This production is believed to have taken place at sites such as Huánuco Pampa and Hatun Xauxa, which were administrative centers and arenas for feasts and public political display orchestrated by the Inka elites, but also at smaller provincial centers (P. Goldstein 2003; Morris 1982; Gose 2000). There are indications that the Inka controlled both production and consumption of *chicha* and that Inka administrators strictly regulated consumption by commoners (Krögel 2015:25). It is less clear, however, if these prohibitions were only valid for certain kinds of *chicha* and in certain contexts. Not surprisingly, we learn from the chroniclers that the Inka emperor had special brews made for him personally, which were aged and very labor intensive to make (Bonavia 2013:262). Cutler and Cardenas (1947:52) mention local traditions suggesting that, formerly, the better types of *chicha* were reserved for the ruling class. Krögel (2015:25) writes that "*chicha* brewed by the *aqllakuna* was considered a sacred food to be enjoyed exclusively by Inca leaders" (Krögel 2015:25). Tschudi (1918) writes of *sora chicha*, which was reserved for the Inka elites and forbidden for everyone else, and Jennings (2014:29) asserts that, as the *mama* and *aqlla* could only produce a fraction of the beer needed in the Inka feasting economy, the *chicha* brewed by the *aqlla* was probably reserved for the most important state occasions (Jennings 2014:29). Gose (2000), on the other hand, believes that the *aqlla* produced a much larger share of the state *chicha* than is often assumed, and that the numbers of girls and young women included in this social category (*aqlla*) was also much larger than assumed.

Based on her research on the Xauxa in the Mantaro Valley, Hastorf (1991:149-52) has suggested that it is probable that much of the *chicha* production was the responsibility of local women. Hastorf has shown that maize consumption in general increased, but isotopic evidence also shows that before Inka conquest, men and women consumed equal amounts of maize. After the conquest half the male population consumed more maize (and meat). If this trend in consumption pattern is linked to the *chicha* economy, it indicates that it was not women's labor that was being celebrated and reciprocated at the ceremonial feasting events.

5.3.7 Discussion of results

It is easy to see how the production of *chicha* in prehispanic times would have made its imprint on the landscape. A common estimate of daily *chicha* consumption, which is considered conservative, is 2.5 liters per person (e.g. Hayashida 2008:167; Jennings 2005:247-248; Costin 2015:63). If we assume that four of the estimated 10 million inhabitants of Tawantinsuyu had 2.5 liters of *chicha* daily, it would amount to 3,650 million (or 3.65 billion) liters of *chicha* annually. Based on the historical information given by Cobo that each household produced on average 76 liters of *chicha* weekly, and assuming that there were one million households in Tawantinsuyu producing *chicha* on a weekly basis, the annual *chicha* production would amount to 3,952 million (3.95 billion) liters. Assuming a total annual *chicha* production of 3.95 billion liters and a production process roughly corresponding to the one in Example 5.3.1, the fuel requirements to cook the *chicha* alone would be 13 million ha of pampa pasture area. The labor requirements would be 5,201 million hours, which means 650 million labor days (assuming an eight-hour labor day), or 1.8 million people working year round exclusively with producing *chicha*.

Assuming the same total amount of *chicha* produced annually (3.95 billion liters) and a production context similar to the one in Example 5.3.2, the fuel requirements to cook the *chicha* would demand 593,000 ha of montane forest or 395,000 ha of *algarrobo/huarango* forest. It is easy to see how a political economy relying to a large extent on the production of huge amounts of *chicha* could have contributed to deforestation in certain areas of the Andes. This amount of *chicha* would have required more than 3,058 million labor hours, that is 382 million labor days (assuming an eight-hour labor day) or 1.05 million people, which would represent more than 10 percent of the estimated total population (of 10 million), working year round to produce the *chicha*.

The agricultural land required to grow maize for this scale of production, and brewing a thin *chicha*, would be 389,000 ha. Brewing a thicker *chicha*, as exemplified in Table 5.3.1, would have required more than 2.7 million hectares of agriculturally productive land.

Larger Inka feasts are believed to occasionally have been of massive scale. The plaza at Huánuco Pampa, for instance, was 20 hectares, and at Pumpu, another Inka administrative center in the central highlands, the plaza was 19

hectares, designed to accommodate very large crowds of people. If we assume that there was one annual feast at the Inka administrative center of La Viña on the North coast, in which the full capacity of its 5.2 ha plaza was utilized, it could have accommodated roughly 50,000 people (Hayashida and Gúzman 2015:295). Using the figures in Table 5.3.2 for calculations, serving all 50,000 people 12 liters of *chicha* would occupy 59 ha of agricultural land for maize production, and require 58,000 eight-hour labor days.

Another aspect which is evident from the results is that the pottery, the artifacts which ancient cultures are often defined by because of their durability, in fact represents only a fraction of what people were actually spending their time on in the late prehispanic Andes. Even the elaborate Inka ware represents only a fraction of the total labor requirements of *chicha* production. It is probable that the Inka *aríbalos* were produced under more specialized and formalized conditions, while the common cookware was part of the household labor tax. Analyzing two *visitas* recorded in the Huallaga Valley, LeVine (1987) has found that Chupachu labor service for the Inka state included 40 seasonal part-time potters, who provided ware for Huánuco Pampa. *Ollas* were crafted locally and then brought to the administrative (and feasting) center situated some 100 km west of the Huallaga Valley. Although the cooking pots would have been used for other kinds of cooking as well, they would almost certainly also have been used for cooking *chicha*. The pottery obligation represented around 1 percent of the Chupachu population (40 potters out of a tribute population of 4,000 households). The analysis illuminates how and to which extent the labor required for making the *chicha*, which would end up being served by the Inka ruler (or rather those representing him) to those who had been of service to him, came from the communities themselves.

5.4 Stone walls

The most enduring and visible legacy of the Inka Empire is without doubt its monumental architecture and characteristic stone masonry, exemplified by sites such as Machu Picchu, the Qorikancha or Sun Temple in Cuzco, and the megalithic ziq-zaq walls of Saqsaywaman. Upon seeing the walls of Saqsaywaman, Pedro Sancho de la Hoz, who was the secretary of Francisco Pizarro, wrote that “neither the bridge of Segovia nor any buildings that

Hercules or the Romans built are so worthy of being seen as this" (Gasparini and Margolies 1980:282; Nair 2015:25). Some of the stone walls composing this monumental architecture were so exquisitely made and the stones so well fitted that still today, as the saying goes, not even a knife's blade can be inserted between them. While most other activities of the Inka are not immediately recognizable in the landscape, the Inka walls remain tangible evidence of their once omnipotent presence and dominance. Another enduring architectural feature of the Andean landscape involving stone walls are the agricultural terraces covering the valley slopes. It has been suggested that the term used by the Spaniards to describe bench[58] terraces (*andenes*) is the root of the name which has been applied to the whole region of the Andes (Denevan 2001:170). [59] The same Pedro Sancho wrote that "between Tumbes[60] and Cuzco all the mountain fields are made in the guise of stairways of stone" (Donkin 1979:20). Although this was certainly an exaggeration, it has been asserted that, taken together, agricultural terracing in the Andes "eclipses even the largest monuments in terms of both area and labor investment" (Goodman-Elgar 2009:80).

In this case study I will estimate how much labor was embodied in three categories of stone walls in Tawantinsuyu, two examples of high-prestige fine Inka masonry walls, *ashlar* and *cyclopean*,[61] and one example of a common fieldstone wall, sometimes referred to as *pirqa*,[62] which was the common method used for constructing retaining walls for terraces. The aim is to assess how much labor and productive space the Inka appropriated through

[58] The construction of bench terraces is associated with the Inka period, and are characterized by high stone walls often built on steep slopes and with a level planting surface. Bench terraces are almost always associated with irrigation (Denevan 2001:178). The Quechua term for terrace is *pata*.

[59] See Gade (1999) for a different view, namely that the term is derived from the Quechua word *Anti*, which was used for the inhabitants of *Antisuyu*.

[60] Tumbes is a city of prehispanic origin, located in northern Peru near the border to Ecuador. The Spanish conquistador Fransisco Pizarro, who led the force attacking and capturing the last Inka (Atawalpa) in Cajamarca in 1532, is said to have visited Tumbes already in 1528 and set out on his military campaign from there.

[61] The terminology for and classification of Inka fine stone masonry in the literature is not consistent. I use the term ashlar masonry to refer to the rectangular masonry style, exemplified in Inka walls such as those of the Qorikancha in Cuzco, and cyclopean masonry for megalithic Inka walls such as those of Sacsaywaman and at Ollantaytambo.

[62] *Pirqa* may refer both to mortared and dry fieldstone walls.

their imperial architecture, and more specifically through the construction of stone walls.

5.4.1 The Inka culture of stone

Although this analysis will deal with stone walls, it should be stressed that there was much more to Inka architecture than stone. Other construction materials used by the Inka were earth, wood, and vegetal fibers (Protzen 1993:157). Most Inka buildings were constructed with mortared fieldstone, but *adobe* and *tapia*[63] were also common elements of Inka architecture, even in high-prestige buildings. There are examples of structures with walls that have cut and fitted stone on the outside and mortared fieldstone (*pirqa*) on the inside (Protzen 1993:215), and the upper part of many Inka walls, even of the best cut and fitted stonemasonry, was often made with *adobe* bricks (Moorehead 1978; Protzen 1993:214). Wood was mostly used for the construction of roofs in elite buildings, and vegetal fibers were used as roofing and for tying. However, the emphasis on stone in Inka architecture is not coincidental. Stone has been characterized as an essential Inka substance (Dean 2010:76), and the Inka deliberately associated themselves with stone. In Inka lore, stones had played an important role in the Inka coming to power; in the decisive battle with their neighbors, the Chankas, which the Inka were losing, the great stone boulders referred to as the *pururaucas* came to life and secured the Inka victory. Stones known as *wawqi* could act as stand-ins for the Inka king, travel in his stead, and were in such cases treated as if they were the Inka himself, e.g. fed and clothed (Dean 2010). Inka rulers and elites are often depicted in the act of making Inka architecture, especially fine quality stone masonry, by touching and transforming the stones, highlighting their ability to shape and identify with sacred landscapes and materials (Nair 2015:31). In reality, of course, the Inka ability to transform and shape landscapes and stones depended narrowly on their ability to appropriate and control the labor of their subjects.

---

[63] *Adobe* bricks are made from a mixture of water, mud, and organic material such as straw. Inka *adobes* were mostly shaped by hand, not molded in forms. *Tapia* is similarly made of a mud mixture which is filled between two vertical planes to form a wall, a method used mostly on the central coast and less frequently in the highlands (Moorehead 1978:66).

5.4.2 Inka walls

The element of Inka architecture which is at the center of this analysis is the stone walls. Stone walls were by no means the only, but arguably the most important, components of Inka architecture. Although the high-prestige walls of exquisitely fitted stones have received most attention, the most common method of constructing stone walls was what is referred to as *pirqa*. In the modern literature, *pirqa* stone masonry often refers to the method of constructing walls using unworked stacked fieldstones sometimes laid in clay mortar, and is contrasted to the high-prestige walls constructed with cut stones and without mortar. *Pirqa* fieldstone masonry was the construction method used to build most commoner's houses as well as other structures, and according to Protzen and Nair (2015:224), it was by far the most common method of constructing stone walls in the Inka Empire. In early colonial Quechua, *pirqa* simply meant "wall," and the Inka had many terms to describe different types of walls according to their age, condition, material, and building technique (Nair 2015:26; Muelle 1978:574). The term for *adobe* walls, for instance, was *tica pirqa* and for stone wall *rumi pirqa.* Even if these different categories of walls were those most commonly constructed in the Inka Empire, it is the fine stone masonry of the Inka which has received the most attention. The European contemporaries of the Inka marveled at the perfectly fitted Inka stone walls, and often compared them favorably to European construction. The superiority of Inka walls was probably one contributing factor to the destruction and tearing down of so many Inka structures by the Spanish in the years following the invasion. Garcilaso very tellingly attributes much of the destruction to jealousy rather than a simple need for construction material, and as Inka walls were potent symbols of power, it seems logical that their iconoclastic demolition would have been an element in the colonial efforts of the invaders to establish themselves as the new lords of the land. Fortunately, some of the Inka walls have remained standing and have inspired and informed a wealth of scholarly work. This analysis will draw on some of this work. While Inka fine masonry practices survived into early colonial times, they were eventually abandoned, but some of the Spanish chroniclers recorded information on Inka stone masonry. Garcilaso, for instance, wrote that the Inka had no other tools to work stone than "some black stones they called *hihuana* with which they dress the stones by pounding rather than cutting" (Protzen 1985:176), and Cieza writes that when working stone, Andeans used nothing but stone to do so (Bengtsson

1998a:10). Many nineteenth and twentieth century observers could not accept that such exquisitely made walls could have been constructed with no other technology than a hammer stone, and until quite recently the hypotheses on Inka masonry construction methods were largely based on speculation, ranging from an extraterrestrial origin to suggestions that the Inka had knowledge of herbal mixtures to soften rock (Protzen 2000:212). The perfect fit of stones also led to more prominent hypotheses about the surfaces of the adjoining stones being ground against each other and thereby achieving their perfect fit (e.g. Ravines 1978:559). Although grinding and polishing were probably part of the construction process in some cases, this theory has been refuted (Protzen 1985:178). There seems to be general agreement among most scholars today that the most common tool used by the Inka stone masons to work stone was the hammerstone (Menotti 1998:80). This does not exclude the possibility that other tools or techniques were used, but pounding with hammerstones was the main method used to work stone in the Inka Empire. During the 1980s Jean-Pierre Protzen (1983; 1985; 1986; 1993) carried out experiments showing that even the finest Inka walls could indeed have been constructed using only very simple tools such as hammerstones to shape and fit the stone blocks together in walls. My analysis of the labor requirements of Inka fine masonry is based largely on Protzen's experiments.

As is the case with other Inka crafts, stone work and stone masonry carried out in the Inka Empire cannot easily be classified into uniform categories of fine and common. Nevertheless, modern observers of Inka architecture are rarely in doubt about whether they are observing a high-prestige fine masonry Inka wall or a common one, and neither, we must assume, were the contemporaries of the Inka. The problem of classification of Inka walls by foreign observers goes back at least to Father Cobo, who had difficulties in finding a suitable term for the uncoursed polygonal masonry which did not fit easily with the Spanish architectural vocabulary (Dean 2010:80). Rowe (1944, 1946) observed that it appeared as if the types of fine Inka masonry mimicked the common construction techniques in the Andes. The fine coursed or rectangular masonry mimicked the appearance of *tapia* and *adobe* walls, and the polygonal masonry mimicked in a refined way the rustic or *pirqa* fieldstone construction technique. This classification of Inka stone masonry styles into *pirqa* or rustic and polygonal and coursed fine masonry has been very influential and many scholars recognize this grouping of fine masonry styles referred to as the rectangular and the polygonal (J. Rowe 1944, 1946; Harth-Terré 1965; Kendall 1985:46). A more detailed study and

classification of Inka stone work was proposed by Agurto Calvo (1987), who recognized five distinct types of Inka stone wall masonry: rustic, cellular, encased or fitted, sedimentary, and cyclopean. The rustic style corresponds roughly to fieldstone masonry, while the last four types are fitted fine masonry. The cyclopean masonry style, exemplified at Saqsaywaman and characterized by the very large size of the building stones, will constitute one of my examples of the labor requirements of fine stone masonry. Niles (1987) distinguished three basic styles of Inka masonry based on the quality of fit, and suggested that the Inka stylistic traditions of stone construction could be divided into three categories: fieldstone masonry, intermediate masonry, and high-prestige masonry. Fieldstone masonry were walls made of locally available fieldstone set in clay mortar and was used, for example, in commoners' houses. The category of high-prestige masonry, according to Niles, includes both the coursed (rectangular) or ashlar and polygonal styles and is rarely found outside of the Cuzco area (Niles 1987:277).[64] Niles' classification is based on the quality of fit and therefore emphasizes the process of construction and the amount of labor involved in the construction of the walls, rather than its appearance. In Niles' (1987:277) own words, "in a general sense, the most important buildings have the style of masonry that represents the most work."

According to Dean (2010:76,112-113), the Inka themselves made a distinction between common and fine masonry, as they had two distinct terms referring to the process of building common verses high-prestige walls. The process of building an ordinary stone wall was *pircani*, while the working of finely joined masonry was *kaninqakuchini*. The term *kaninqakuchini* is derived from the verb *kanini* which means to bite or nibble. The "[n]ibbling refers to the persistent pecking away at stone blocks with hammer-stones to achieve the much-admired tight joints featured in dressed-stone Inka walls" (Dean 2010:113). To the Inka, finely worked stone of whatever shape or size was apparently thought of as nibbled stone. Considering the importance of ritual commensality in the Andes, and of consumption as a route of communication with the natural and supernatural world, the association of working stone with eating is interesting. The visible traces of this nibbling process conveyed the value of the walls within the Inka system, as the bites testified to the labor invested in the block (Dean 2010:115). This would also

[64] Although fine stone masonry is concentrated in the Cuzco region, it is found as far north as Ecuador and as far south as the Titicaca region (Bengtsson 1998a:1).

explain why Inka masons sometimes polished their building stones not on the visible face of the wall, where the fineness of the nibbling could be seen, but in the joints, to improve the fit (Protzen 1993:157). While all nibbled stone was prestigious, there was great variation, from roughly nibbled to nearly smooth (Dean 2010:115), and there is every reason to believe that this variation was the most crucial factor for determining the relative fineness of Inka masonry. As a way of acknowledging Inka thinking about worked stone masonry, Dean introduces the phrase "nibbled masonry" to distinguish it from common masonry.

While Dean (2010:114) argues that the difference between coursed ashlar (rectangular) and polygonal masonry was therefore not as significant to the Inka as it has been for modern scholars, there are indications that coursed ashlar masonry was more prestigious than polygonal. Coursed ashlar masonry is found only in the most sacred and important buildings such as the Qorikancha and Aqllawasi in Cuzco, the Sun Temple in Machu Picchu, and the viewing platforms *ushnu* at Huánuco Pampa and Vilcaswaman (Nair 2015:27). Protzen (1986) has noted that the creation of polygonal masonry was less complicated and required less skill and planning than that of ashlar masonry; when making ashlar masonry, stone masons could easily make the mistake of flaking off a piece of stone (Protzen 1986), which would make the block unsuited for what it was intended for. This would not be the case with polygonal masonry, where the creation process was more dynamic, and allowed for unplanned variation (Nair 2015:27-28).

There are many ways to classify Inka stone walls, and not all of them have been mentioned here. In my examples I will calculate the time and space embodied in three types of walls which have been discussed above: Nibbled coursed ashlar walls, nibbled cyclopean walls, and fieldstone or *pirqa* walls.

5.4.3 Inka stone masonry in historical perspective

While the *pirqa* construction technique was used before, during, and after the Inka, there has been some debate concerning the origin of Inka fine stone masonry. Inka imperial architecture was of course established on the foundation of long-standing pan-Andean practices, and architectural and stone masonry elements have been traced both to Wari and to Tiwanaku. The first examples of worked stone in the Andes predates the Inka by millennia. Protzen and Nair (1997) mention early examples of dressed stone at Cerro

Sechín dating to around 1000 B.C., and well fitted dressed stone was used at Chavín de Huántar between 400 and 900 B.C. From the beginning of the Early Intermediate Period, elaborate cut stone masonry is present at Pukara, and between *ca.* 200 B.C. and A.D. 1000, the art of cut stone masonry developed and reached new heights of maturity and perfection at Tiwanaku. The creation of a distinct Inka imperial architecture is attributed to Pachakuti Inka, the ninth Inka ruler, who is said by Betanzos to have ordered the city of Cuzco evacuated while it was transformed from a "city of straw and clay" into an imperial capital of stone (Gasparini and Margolies 1980:44).[65] Spanish chroniclers Cieza and Sarmiento de Gamboa report that Inka fine stone masonry originated from Tiwanaku (Protzen and Nair 1997:146), and Cobo wrote that Pachakuti Inka ordered that the techniques of Tiwanaku masonry were studied so that they could be used in Cuzco (Gasparini and Margolies 1980:7). There are also reports that the Inka used stone masons, skilled in fine masonry, from the Tiwanaku area to carry out their construction work as part of their *mit'a* labor obligation. While legal documents support the idea that the Inka imported masons from the Tiwanaku area, the assumption that they were already trained as fine masons has been questioned, mainly because there are no known examples of fine stone masonry from the five hundred year period between the demise of Tiwanaku and the rise of the Inka (Gasparini and Margolies 1980:11). More recent discoveries and investigations, however, seem to suggest continuity in the masonry and architectural as well as the ceramic traditions in the region (Kesseli and Pärssinen 2005; Pärssinen 2015). Nevertheless, there are significant differences between Tiwanaku and Inka fine masonry as regards both the appearance and the construction techniques (Protzen and Nair 1997).

5.4.4 Terrace retaining walls

As mentioned above, another remarkable and characteristic type of wall construction in the Andean landscape was agricultural terraces. Donkin (1979:33) describes the terracing organized by the Inka as "part of a systematic and nationwide policy of land improvement and colonization" (Donkin 1979:33). The role of terracing in the colonization of the Andean

[65] The reign of Pachakuti Inka has been dated between 1438 and 1471 (Julien 2009:105), see also Table 4.1. If we accept this chronology, then practically all known examples of Inka fine masonry were constructed in the century between 1438 and 1532.

landscape is mentioned several times by the chroniclers. Garcilaso writes that most of the terraces belonged to the Sun and the Inka state, because the Inka had ordered them made. Others relate that Pachakuti had very long terraces constructed and sown in order to provide for his army (Donkin 1979:20). The Inka terrace construction efforts are presented as a program of land reclamation, and as an expansion of cultivable land rather than as appropriation of land. This may be partly true, but the construction of terraces on formerly unproductive land often required enormous amounts of labor. One documented case is the creation of Wayna Qhapaq's estate at Yucay, which involved not only earth-moving on a massive scale, but also changing the course of the Urubamba River (Niles 1999). Donkin writes that it appears that terrace building in the Andean valleys under the Inka had as its prime object the expansion of maize cultivation (Donkin 1979:34). Thus, terrace construction probably to a large degree served to make more land suitable for maize production. This might have increased overall production, but for the people who were colonized, it meant the loss of control over labor and basic subsistence needs (Nair 2009:116).

As with other imperial architecture, Inka terraces were generally easily distinguishable from common terraces. In Donkin's (1979) words, "Inka terracing appears to overstep the bounds of mere utility and to take on symbolic significance." The characteristic so-called bench terraces associated with the Inka can be viewed as monumental architecture in that their size, the quality of construction, and the relevance of their appearance clearly do not serve any practical need. Moreover, the Inka probably would not have classified terraces as belonging to a practical and profane sphere of agricultural production, as the modern observer is inclined to do. On the contrary, some terraces were important sites of ritual, and the Inka integrated terraces into their finest monuments (Goodman-Elgar 2009). Some of the most impressive stone walls in Cuzco, formerly believed to have been palace walls, were in fact the walls of free-standing monumental terraces, such as the terrace of Manco Chuqui, which is known today mostly for the twelve-angled stone fitted into its wall (Herring 2010). In other words, terraces were a crucial element of imperial Inka architecture and simultaneously served political and productive purposes. Niles (1982) has noted that the heaviest concentration of Inka terraces was around royal estates in the heartland, suggesting that the symbolic role of terracing was of great significance for the Inka (Nair 2009:116).

5.4.5 Who made the walls?

Although, as we have seen, Inka rulers were often depicted in the act of making fine stone masonry, there is little doubt that most of the work was carried out by large numbers of *mit'a* workers (Nair 2015; Murra 1982). Historical sources indicate that the construction of stone walls was a distinct labor tax category. For instance, the *visita* census from Chupachu, which was transcribed from an Inka *khipu* in 1549, records that the Chupachu owed 400 workers who were continually stationed in Cuzco to "build walls" (Gasparini and Margolies 1980:9; Murra 1982; Bengtsson 1998a:11). Another 200 couples (400 people) were ordered to Cuzco to provide for the stone workers (Murra 1982; Julien 1988). Murra (1982:241) believes that they were *mit'a* laborers who rotated annually. The 400 wall builders would have represented 10 percent of the tax paying population of the Chupachu, and the 400 people stationed in Cuzco to provide for them another 10 percent. In all, this would mean that 20 percent of the adult tax paying population of the Chupachu were devoted to imperial construction work in Cuzco. Murra (1982:251) expressed skepticism about this figure as it appears very high, and it has been observed that if several other ethnic groups sent similar proportions of their population to Cuzco, they would literally have no place to stand (Lohmann Villena, quoted in Murra 1982:258, note 10). From other historical records, we know that not all polities or ethnic groups sent equal numbers of people for the same tasks. Some groups were exempt from wall building (Murra 1982). Also, the people sent on their *mit'a* to "build walls in Cuzco" need not necessarily have worked within the city of Cuzco itself, but could have been sent from there to other construction sites, for example in the Urubamba Valley (Bengtsson 1998a:11-12).

It is not certain what exactly was included in this category of "building walls," or what specifically "masons in Cuzco" (Julien 1988:265) were doing, but it may have referred to more or less all construction of imperial architecture, including the Inka road system and the associated architecture of waystations storage facilities and more, which was a major undertaking (e.g. Hyslop 1984; Bauer 2006). Road construction is not mentioned in the *khipu* transcription from 1549, but in a later inspection from 1562, it is reported that the Chupachu had built and were responsible for maintaining parts of the Inka road system (Murra 1982:245). The construction of agricultural terraces was no doubt in many cases carried out by *mit'a* workers, and the construction of the terrace complexes of the royal estates in the Urubamba

Valley could well have been included in the category of "building walls" or "masonry." It also seems plausible that the construction and maintenance of agricultural terraces in the provinces could have been part of the agricultural *mit'a* obligation, but the construction of some of the bench terrace complexes would have required a high level of planning and organization (Donkin 1979:33). Regardless of which labor tax category terrace construction was classified as, it is quite clear that Inka terraces would have been constructed with *mit'a* laborers, and that the labor appropriated for terrace construction was significant. The Inka identified masons in general as *pirqakamayuq,* "wall makers," and given the varying quality of Inka masonry, it has been argued that these wall makers must have differed in rank and status, and that since some tasks required more skill than others there must have been separate categories of workers (Nair 2015:27-29; Dean 2010). Nair (2015:27-28) has suggested that the *pirqakamayuq*, who were full-time specialists, trained the unskilled *mit'a* rotational workers to make both fine masonry and common masonry walls.

As we have seen with the example of Wayna Qhapaq's royal estate at Yucay, the magnitude of Inka construction projects could be quite overwhelming. The construction of the Yucay estate, which reportedly demanded 150,000 workers, implicated not only the erection of structures but a complete transformation of the landscape, which included shifting the course of the Urubamba River to the other side of the valley. We do not know the duration of the construction period or for how long the 150,000 workers stayed at the site, but in the thirty years between its creation and the European invasion, the western end of the estate was not completed (Niles 2015:238). According to historical documents, the transformation of the landscape sometimes meant the simultaneous transformation of the social identity and status of the people who lived in the area before it was turned into an estate. A witness was recorded as explaining how Wayna Qhapaq had "consulted with his gods and the Sun and had told the informant's father that it was no longer right for him or his relative or anyone else in his *ayllu* to be *curacas*. Rather, they should become common Indians" (Niles 1999:134). In Inka legal theory, these people were classified as *yanakuna*, and placed in perpetual service of the estate's owner (Niles 1999:126). The Inka ruler is also said to have ordered 2,000 households from several ethnic groups to come to live and work on the terraced fields around his Yucay estate, mainly devoted to maize cultivation (Niles 2015:238). This should remind us that the appropriation of labor

involved in Inka terracing and other construction projects did not stop once the initial phase of construction was completed.

Example 5.4.1 Labor time embodied in two kinds of Inka fine stone masonry: Ashlar and cyclopean

The case of stone wall construction differs in a fundamental way from the other two case studies of textiles and *chicha*, because the raw material required, stone, does not "grow" through photosynthesis. This does not mean that production processes involving stone do not require productive space, but Tables 5.4.1 and 5.4.2 will only contain information on the embodied labor time of stone walls.[66]

The figures presented in Table 5.4.1 are to a large degree based on the reports of Protzen, who during the 1980s carried out a number of experiments on stone masonry in the Andes. The results are reported in a number of publications (Protzen 1983; 1985; 1986; 1993; 2000). The first experiments were carried out in the Rumiqolqa quarry, located some 35 kilometers east of Cuzco. The Rumiqolqa quarry was used by the Inka and continued to be exploited during colonial and modern times. However, a relatively undisturbed area of the quarry, the so-called Llama Pit, has provided much information about Inka activities there, and the production processes involved in Inka stone masonry. The andesite blocks that were made to construct some of the finest buildings in Cuzco, such as the Qorikancha and the Aqllawasi, are known to have derived from the Rumiqolqa quarry. In the Llama Pit, Protzen found numerous stone blocks in different stages of preparation, left there by Inka masons, probably at the time of the European invasion. Protzen took a block measuring approximately 25 × 25 × 30 cm and used hammerstones to pound it into a similar shape as the Inka stone masons had done some 500 years earlier. I am assuming that when Protzen had finished his stone block, and it was brought to the site of construction and fitted into the wall, it measured 20 × 20 × 25 cm. This would then represent some of the smallest examples of stone used in Inka fine masonry (Bengtsson 1998a:1). I am also assuming that all blocks in the wall were of a similar size. With these assumptions, one square meter of wall (20 cm deep) would be composed of 20 stone blocks. These stone blocks would be so-called parallelepipeds[67] with

[66] We should keep in mind, however, that labor always also requires land for food energy.

[67] A parallepiped is a solid body of which each face is a parallelogram, meaning that opposite sides are parallel.

six faces and 12 edges. The stone block prepared by Protzen in this experiment would be similar in shape, if not generally in size, to the stone blocks used to build the walls of the Qorikancha and the Aqllawasi.

Later experiments were carried out by Protzen in the Ollantaytambo area, another important Inka site in the Urubamba Valley, and at the nearby quarries of Kachiqhata, which provided building stones for the walls of Ollantaytambo. From the Kachiqhata quarries the Inka extracted very large rhyolite blocks and transported them to Ollantaytambo. Based on his observations of the blocks left in the quarry and his own experiments, Protzen estimates the labor involved in preparing/nibbling a block 4.5 meters long, 3.2 meters wide, and 1.7 meter high, and weighing approximately 60 tons, corresponding to an actual block in the quarry (Protzen 1993:173). The calculations of the labor requirements of cyclopean stone masonry will be based on such a stone block.

Table 5.4.1
Labor time (hours) embodied in Inka fine masonry walls (per m^2), ashlar and cyclopean.

	Ashlar masonry	Cyclopean masonry
Quarrying[a]	-	-
Preparation/nibbling	50 hours[b]	146 hours[c]
Transport	318 hours[d]	280 hours[e]
Fitting/nibbling	54 hours[f]	280 hours[g]
Polishing	36 hours[h]	2 hours[i]
Total	458 hours	708 hours

Notes to Table 5.4.1

a. Quarrying: Although I have not been able to find information to base an estimate of labor time on, the labor category of quarrying is included in the table because quarrying in some instances would have required a labor effort. At Rumiqolqa for example, the Inka did quarry rock, but it was done by inserting pry-bars of wood or perhaps bronze in already existing fractures and prying it lose, a process that would not have been very labor demanding (Protzen 1985:167-169). At Kachiqhata, as in other places (Protzen 2000:112), the Inka did not actually practice quarrying in the proper sense, but simply searched in natural giant rock falls and carefully selected the stone blocks (Protzen 1985:165).

b. Preparation/(nibbling), ashlar masonry: In the experiment carried out by Protzen on the small andesite stone block preparing three faces and cutting five edges took him "no more than 90 minutes" (Protzen 1985:173-174). Most Inka masonry blocks were worked on five faces and on 8 edges as well (leaving the four edges around the unworked sixth face of the stone uncut). This means that after 90 minutes, Protzen had completed almost exactly 3/5 of his work on the block. The complete preparation time can therefore be calculated as 90 × 5 / 3 = 150 minutes. Assuming there were 20 of these stone blocks in one square meter of wall, the labor requirement of preparing/(nibbling) would be 150 × 20 = 3,000 minutes or 50 hours.

c. Preparation/(nibbling), cyclopean masonry: Based on the experiment with the large rhyolite stone block carried out by Protzen in the Kachiqhata quarry, he estimates that pounding out a section of rock measuring 75 cm × 180 cm = 1.35 m^2 would take one worker 15 days, working 7 hours a day. This means that to prepare/nibble 1 m^2 required 15 days × 7 hours = 105 hours / 1.35 m^2 = 78 hours. Because the natural fracture planes on the rocks found in the quarries mean that most blocks have two relatively clean faces to begin with, they did not need to be prepared. Taking this into consideration (and thus reducing the labor requirements roughly by half), Protzen suggests that a large stone block measuring 4.5 × 3.2 × 1.7 meters could have been prepared by 20 workers, working 7 hours a day for 15 days (Protzen 1993:173). If we assume that the largest face of the block would have ended up as the face of a wall, it would have represented a wall surface of 4.5 × 3.2 = 14.4 m^2. The labor requirement per square meter of cyclopean wall would thus amount to 20 workers × 15 days × 7 hours = 2,100 hours / 14.4 m^2 = 146 hours.

It is worth noting that to work the whole surface of the rock measuring 4.5 × 3.2 × 1.7 meters, the surface being 4.5 × 1.7 × 2 + 4.5 × 3.2 × 2 + 3.2 × 1.7 × 2 = 54.98 m^2, would require 54.98 × 78 hours = 4,288 hours. The work required to prepare or nibble the same surface area of the large stone was almost 12 times more time demanding than it was for the small andesite block. Protzen writes that it took him 20 minutes to prepare one face of the andesite block (Protzen 1985:173). Assuming that the face measured 25 × 20 cm = 500 cm^2, preparing or nibbling would have required 6.6 hours per m^2. Preparing or nibbling 1 square meter of the large block, according to Protzen's experiment, required 78 hours (see above). The labor requirements of preparation/nibbling thus vary by a factor of 12 between Protzen's two

experiments. The lower labor requirements for the small block could partly be explained with the fact that splitting[68] may have been more common in working smaller stones (Protzen 1993:166-167), but it also suggests that the efficacy of nibbling, although a relatively simple and straightforward technique of pounding one stone against another, varied according to what was to be nibbled and how.

d. Transport, ashlar masonry: In contrast to fieldstone masonry, which is generally constructed with locally available fieldstone, the stone used in fine masonry was carefully selected and often transported great distances to the construction site. The labor involved in transport is very context dependent, particularly since the Inka, when it came to building stones intended for fine masonry, appear not to have sought to minimize the labor involved. In some cases, in fact, the evidence suggests quite the contrary (see e.g. Ogburn 2004a; 2004b). Here we are assuming that the stone came from the *Rumiqolqa* quarry, 35 km from Cuzco. There is no consensus on how stones (or other things) were transported in prehispanic times,[69] but I will base my calculations on the assumption that the typical burden an Inka male subject could carry for a whole day (assuming a six-hour labor day) was 20 kg. Ogburn (2004a:433) writes that the journey between Rumiqolqa and Cuzco could be made in two days. Calculating 6 hours per day, the journey would require 12 hours.[70] As the volume of the stone used to construct 1 square meter of wall would be 20 cm × 20 cm × 25 cm × 20 stone blocks = 200,000 cm^3 or 0.2 cubic meters, and the average bulk density of andesite is 2.65g/cm^3 (Ogburn 2004a:422), the weight of 20 stone blocks required for

[68] Splitting refers to the procedure where the stone mason exacts one blow (or more) to the rock at a strategic point, which makes the rock split. Using this method, large sections of a block could be cleaned with one blow. However, considering the emphasis placed on the process of production, the significance of the nibbling itself, and the marks it left (Dean 2010), there is no reason to believe that splitting was a preferred method.

[69] For example, it has been argued that llamas were used to transport building stones, while others have rejected this hypothesis (Matos Mendieta 1994). As even the smaller stones used in fine stone masonry would often weigh more than one person could carry, it has been suggested that they could have been transported on litters (Agurto Calvo 1987:124). Historical sources also indicate that cloth was used to transport soil and stone (Bengtsson 1998a:43).

[70] The 35 km distance between Rumiqolqa and Cuzco could be covered in 12 hours, assuming a walking speed of approximately 3 km/hour, which is also given by Thomas (1972) as the average slow walking speed in the highland community of Nuñoa in Bolivia. In comparison, average fast walking speed was 5 km/hour (Thomas 1972:129).

one square meter of wall would be 530 kg. This means that 530 kg / 20 kg = 26.5 workers would have spent 12 hours carrying the stone blocks from the *Rumiqolqa* quarry to construct 1 square meter of wall in Cuzco. The labor requirements of transport would thus be 26.5 × 12 = 318 hours per m^2.

e. Transport, cyclopean masonry: While not much has been written about the transportation of smaller stones, the transport of the cyclopean blocks has received more attention. The procedure for transporting large stone blocks reported by Gutierrez de Santa Clara, Garcilaso, and Cieza is that they were dragged using ropes and hides (Protzen 1993:178-179). An indication that this was common practice is illustrated by Guaman Poma in his famous manuscript about the Inka Empire, where a so-called weary stone is said to be so tired of being dragged that it cries tears of blood (see e.g. Cummins 2015:181). Although not mentioned in the historical sources, a number of scholars have suggested that wooden rollers were also used (J. Rowe 1946:226; Lanning 1967:164; Outwater 1978:586; Ravines 1978:565; Kendall 1978[1973]:163), while others argue that the stones were dragged (Protzen 1993:178). Protzen has argued that pebbles or clay could have been used to lessen friction, and based on experiments has calculated that to move the largest boulder in the Kachiqhata quarry, weighing more than 100 tons, up the ramp to Ollantaytambo would require a force of 1,780 people (1993:179). Bengtsson, who has investigated the site of Ollantaytambo, carried out excavations under one of the large building blocks, the so-called *Incaqonqorina*, weighing 70 tons, which was left *in situ* at the foot of the ramp to Ollantaytambo when construction work there ceased around the time of the Spanish invasion. Bengtsson found evidence of tree trunks under the block, not used as rollers, but as rails (Bengtsson 1998a:50). Bengtsson (1998a:52) states that the use of these tree rails would have lessened friction with the ground considerably, and would have reduced the force needed to drag the blocks by 80 percent.

As mentioned, the calculations of transporting rock are based on experiments carried out by Protzen (1993:179). Protzen states that to drag a block on a level horizontal plain requires a force of 70 percent of its weight. For a block of 60 tons the force needed to drag it would be 0.7 × 60 tons = 42,000 kiloponds.[71] Protzen assumes that a person can pull consistently with a force

[71] Kilopond is a unit of force representing the force needed to lift one kilo against standard gravity.

of 50 kiloponds, so to drag the 60 ton block would require 42,000 / 50 = 840 workers. With an upward slope of 8°, corresponding to the general slope of the ramp leading to the construction site at Ollantaytambo, the force increases from 70 percent to 84 percent of the weight.[72] The number of people dragging (with a force of 50 kiloponds each) would then be 60 tons × 0.84 / 50 = 1,008.

Using wooden rails and thereby lessening the required force by 80 percent, as Bengtsson suggests, the force needed to drag the block horizontally is reduced to 20 percent of its weight, which is 60 tons × 0.2 ≈ 12,000 kiloponds, and would thus require 240 people each dragging with a force of 50 kiloponds. The 8° slope of the Ollantaytambo ramp, using rails, would require a force of 34 percent of the block's weight (sin (8°) + 0.2 × cos (8°)). The workforce required would then be 405 people. To drag our imaginary cyclopean block from the Kachiqhata quarry to Ollantaytambo would require 405 people, and the surface area of wall it could constitute could be as much as 4.5 × 3.2 = 14.4 m^2. The remaining question is how much time it took these 405 people to drag the building block the five kilometers between *Kachiqhata* and *Ollantaytambo*. If we assume an average progress of 0.5 kilometer per hour, which corresponds to one tenth of the average fast walking speed of men in the Andean highland community of Nuñoa (Thomas 1972:129), the transportation time would have been 10 hours. The embodied labor time in one m^2 of wall surface would then be 405 × 10 / 14.4 m^2 ≈ 280 hours.[73]

f. Fitting/(nibbling), ashlar masonry: If we accept Protzen's analysis of the construction process in erecting a fine masonry wall (Protzen 1993; 1985), then each stone in a wall was fitted on two sides to its neighboring stones: horizontally on the bedding stone and vertically to stone already in place in the same course.[74] This would be the case for the coursed ashlar masonry but not for polygonal or uncoursed cellular masonry, where the blocks could

[72] According to the equation $K = f \cdot P \cdot \cos a \pm P \cdot \sin a$ (Protzen 1993).

[73] In comparison, if we were to accept Protzen's transport method and use the same variables of calculation, the transport labor embodied in one m^2 of cyclopean wall surface would be 712 hours.

[74] While the load-bearing horizontal joints of nibbled masonry are usually fitted on the whole of the connected surfaces, the vertical joints are sometimes fitted only to the depth of a few centimeters, and then mud or gravel is used to fill the internal gaps. While this is common, it is by no means the rule (Dean 2010:218, note 47; Protzen 1985:180).

have many more sides/angles. With the same andesite stone block described earlier, Protzen made a further experiment of fitting his partially worked block on to another larger andesite block (Protzen 1985:178-179). If we assume the face he fitted measured 20 × 25 cm, the fitted area would be 500 cm^2, and it took Protzen 90 minutes to complete this fit. The vertical face of the stone would measure 20 cm × 20 cm = 400 cm^2, which means that the total stone surface to be fitted would be 500 cm^2 + 400 cm^2 = 900 cm^2 × 20 stone blocks = 18,000 cm^2 or 1.8 m^2. The total labor requirements would thus be 36 × 90 minutes = 3,240 minutes or 54 hours.

g. Fitting, cyclopean masonry: When it comes to the large cyclopean masonry, the method of fitting is not known (Nair and Protzen 2015). There is no direct evidence to suggest that it was done any differently than the fitting of smaller stones, that is, that the fit was tested as many times as necessary (Protzen 1987; see however Lee 1990). The task of moving or tilting back and forth, and lifting blocks weighing as much as 100 tons or more must however have required some kind of additional constructions or mechanisms, such as earthen embankments, ramps, and rigs, but what the exact methods used by the Inka were remains more or less qualified guesswork. The only clue I have found as to the labor involved in the fitting of cyclopean masonry comes from the chroniclers. Moseley (1992:85) writes that Saqsaywaman was "reportedly built by 20,000 laboring over several generations." Betanzos and Cieza both mention that 20,000 worked at the site of Saqsaywaman (which is characterized by its cyclopean masonry). There were 4,000 working the stones in the quarries, and 6,000 who brought them to the construction site. The remaining 10,000 worked at the construction site, writes Cieza, but he does not mention fitting of the stones (Bengtsson 1998a:10). Betanzos also writes that 10,000 worked at the construction site, and adds that the majority of the workers were occupied in bringing the stones from the quarries and putting them into place (Bengtsson 1998a:9). If we take this to mean that the majority (6,000) of the 10,000 working at the site of Saqsaywaman were occupied with the task of fitting the cyclopean blocks, then the tasks of transport and of fitting were of similar proportions and we can tentatively suggest that the labor requirements of fitting roughly corresponded to the labor requirements of transport, which was 280 hours.[75]

---

[75] Although information of this kind reported by the chroniclers cannot be accepted as valid per se, the fact that the chroniclers report these exact figures might be taken to indicate that they received the information from well informed Inka witnesses, and that the Inka

h. Polishing, ashlar masonry: Protzen and Nair (1997:156-7) write that "the Inca, on occasion, polished their building stones, not in the visible face of the wall, but in the joints to improve the fit of stone on stone." The perfect fit between joints desired by the Inka could not be achieved with the pounding or nibbling technique. Therefore, they "went on to grind down the very last unevenness to obtain a joint so tight that the line separating one stone from another almost vanishes" (Protzen 1993:194). Protzen, in a later experiment carried out in the Kachiqhata quarry on a rose rhyolite stone block, also tested the task of polishing. He cut an edge about 25 centimeters long and 6 centimeters wide and, using a flat piece of andesite and a slurry of water and soil, ground the edge. After 30 minutes of this work "all but the deepest pit scars had been erased" (Protzen 1993:194). Assuming such polishing was done on all fitted edges in our wall, every stone block would have 25 + 25 + 20 + 20 = 90 cm of polished edge, and all the blocks taken together would have 90 cm × 20 stone blocks = 1,800 cm of polished edge. The labor requirements would then be 1.2 minutes × 1,800 cm = 2,160 minutes or 36 hours.

i. Polishing cyclopean masonry: If we assume that the surface wall area contributed by the large block was 4.5 × 3.2 = 14.4 m^2, the edges would be 4.5 + 3.2 + 4.5 + 3.2 = 15.4 meters or 1,540 cm. One square meter of wall therefore required 1540 / 14.4 = 107 cm × 1.2 minutes = 128 minutes or approximately 2 hours.

Example 5.4.2 Terrace retaining walls

This final case will be of a *pirqa* or common fieldstone wall, more specifically a terrace retaining wall. Table 5.4.2 shows only the labor requirements of constructing the stone wall itself and not the terrace of which it was part.. The labor requirements for constructing a terrace would have depended on many other factors such as if and how the terrace fill was levelled, the width and height of the terraces and the volume of the fill (Williams 1990). Also, the necessary quality of the stonework generally

---

administrators had some form of standardized schemas, no doubt recorded in their *khipu*, when allotting labor time demands to the different tasks involved in the construction of monumental architecture and different masonry styles. The figure of 280 hours can also be checked independently by noting that of the previously mentioned 20,000 men working at Saqsaywaman, one fifth (4,000) worked in the quarries. According to Table 5.4.1, this task required 146 hours per m^2. The total work then should be 5 × 146 = 730 hours per m^2, which compares favorably with the total of 708 hours in Table 5.4.1

increases with the height of the wall and the volume of the fill, and the thickness of terrace walls is related to the volume of the fill (Donkin 1979:32). Bench terraces, the terraces associated with the Inka, could be made of cut or shaped and fitted stone, and the terrace walls sometimes consisted of two rows of stone, separated by rock rubble (Denevan 2001:178). These factors are not reckoned with here. The labor estimates shown in Table 5.4.2 are derived from experiments with terrace (re)construction in the Colca Valley of Peru. A number of such restauration programs were carried out during the 1980s, some of which were presented in the volume edited by Torre and Burga (1987), *Andenes y Camellones en el Peru Andino: Historia, Presente y Futuro,* for example Araujo (1987), Colman (1987), Masson (1987), and Ramos (1987). Treacy (1994) explicitly discusses the results of these modern experiments in a prehispanic and archaeological context, and the calculations in Table 5.4.2 are based on Treacy's estimates of labor requirements.

Table 5.4.2
Labor time (hours) embodied in retaining terrace wall (per m^2).

	Fieldstone terrace wall
Constructing wall (stacking stone + compacting earth)[a]	2.5 hours
Collecting fieldstone[b]	5 hours
Total	7.5 hours

Notes to Table 5.4.2

a. Constructing wall: These figures are derived from experiments with terrace (re)construction in the Colca Valley in Peru (Treacy 1987, 1994). The construction process involves stacking the stones, filling with rock rubble, and compacting earth against the wall. Treacy (1994:152) estimates that under good conditions two men can construct a terrace retaining wall of 80 m^2 in 17 days, working six hours a day. One square meter of new wall would then require 2 workers × 17 days × 6 hours / 80m^2 = 2.5 hours.

b. Collecting fieldstone: While two men working together can thus construct a fieldstone wall at a pace of 0.8 square meters per hour, their family members may collect the stones needed for construction (Treacy 1994:152). Their wives can collect the larger stones, while the children gather smaller stones and rock rubble to be used as fill behind the wall (Treacy 1994:143). Treacy does not mention how many children are working, and the labor requirements for this task will of course depend in part on the availability of

stone. I have calculated two additional people per wall builder, which means the labor requirements of collecting fieldstone are 5 hours per m^2 of new wall.

5.4.6 Discussion of results

The results in tables 5.4.1 and 5.4.2 are estimates of the labor embodied in Inka stone walls, but it should again be stressed that there was significant variation in the labor requirements, particularly as regards Inka fine masonry. One of the variables was the fineness of the nibbling, a variable which is clearly visible on the wall. Other variables were and are still not immediately visible on the walls, at least not for those who are not familiar with their historical context. There are indications that, around the time of the Spanish invasion, a political fraction of the Inka royal elite was developing the northern part of the empire, in what is today Ecuador, into a competing imperial center. Such a center of course had to have buildings of fine masonry. One of the narratives recounted by a number of the chroniclers (Ogburn 2004a:420) was that the stones to build the Inka center at *Tomebamba* (modern day Cuenca in Ecuador) were transported from Cuzco, a distance of more than 1,700 km by road. Modern archaeological evidence shows that this was in fact very likely the case (Ogburn 2004a). At least 450 worked Inka stone blocks of the kind used to build high-prestige buildings such as the Qorikancha have been found around the site of Paquishapa in the Ecuadorian highlands, each stone weighing between 200 and 700 kg (Ogburn 2004a:422). If we assume, as was apparently sometimes the case, that the transport route from quarry to construction site was 1,700 km, and that this distance could be travelled at the same pace as the 35 km distance between the Rumiqolqa quarry and Cuzco, that is 3 km/h, then the transport labor embodied in one square meter of wall would be roughly 1,700 km/35 km ≈ 50 times the labor involved in transporting stone from the *Rumiqolqa* quarry to Cuzco. In this case, transportation would represent more than 99 percent of the labor requirements involved in constructing one square meter of fine masonry wall in Ecuador.

Estimating the total labor inputs into Inka imperial stone wall construction is not very plausible, as most Inka buildings are only partially preserved and we do not know their original size and the area of wall. For example, only sections of the Qorikancha and the Aqllawasi in Cuzco remain intact. Generally, if we compare the labor requirements of fine masonry walls and

fieldstone walls, as exemplified in Table 5.4.1 and Table 5.4.2 respectively, the construction of a high-prestige wall was up to one hundred times more time consuming than a common fieldstone wall per square meter.[76] In other words, a fine masonry Inka wall can embody one hundred times the labor of a common wall.[77] The symbolism of such a wall was undoubtedly felt intuitively by the contemporaries of the Inka – the message inscribed in the wall is that the people who were able to order such a wall erected were in the vicinity of one hundred times more powerful than the people who carried out the orders.

Some of the chroniclers attributed all the terraces in the Andes to the Inka, but extensive terracing in the Andes predates the Inka realm by at least a millennium, and the earliest evidence of terracing has been traced as far back as 2400 B.C. (Denevan 2001:199). Donkin (1979:33-34) stated that in contrast to most terraces which are small and irregular, and probably constructed piecemeal by single families or small groups, terracing organized by the Inka state was part of a systematic and empire-wide policy of land improvement and colonization. Large-scale terrace construction is also associated with the earlier Middle Horizon Wari Empire (c. A.D. 500-1000). Archaeological investigations in the Carahuarazo Valley, for instance, have dated all terrace construction to that period (Schreiber 1987:271-273). In 1983, Masson estimated that 1 million hectares of land in the Andes was terraced (Denevan 1987:265), but later modified this figure to 600,000 hectares (Denevan 2001:175).[78] To estimate the area of terrace walls, we may assume that the average slope of terraced area in the Andes is 20 percent.[79] As the area of vertical terrace wall is a function of slope (Williams 1990), one

---

[76] In the example above of the stones imported to Ecuador from Cuzco, the embodied labor was more than 2,400 times the labor embodied in a common wall.

[77] The stonework of a free-standing mortared wall of the kind found in most commoners' houses, for example, would require approximately the same amount of labor as the construction of a drystone retaining wall. The production of mortar would however have required additional labor. In fact, the large amounts of mortar necessary for mortared masonry is given as a reason for the abandonment of this construction method in the Andes today (Sillar 2013).

[78] This estimate, however, does not take into consideration the forest covered terraces on the eastern slopes of the Andes (Denevan 2001:175).

[79] Denevan writes that bench terraces range between 1 to 5 meters in height (Denevan 2001:178) and 5 to 15 meters in width (Denevan 2001:180). The average proportion between height and width is then 1:5, which corresponds to a slope of 20 percent.

hectare of terraced area, with a slope of 20 percent, would contain 2,000 m^2 of terrace wall. The labor requirements of wall construction would be 2,000 $m^2 \times 7{,}5$ hours = 15,000 hours, or 2,500 labor days (assuming six hours of work per day). The 600,000 ha of terraced land thus represent a labor effort in wall construction of 9 billion hours or 1,500 million labor days. Even if not all terraces were constructed on Inka initiative, the Inka state appropriated a significant portion of the produce. Assuming the terraces were all in use and were constructed or reconstructed/renovated during a thirty year period,[80] the embodied labor would amount to 15,000 hours × 600,000 ha/30 years = 300 million hours per year, which would require 137,000 persons working six hours a day, 365 days a year, or roughly 1.4 percent of the total population continually occupied with terrace wall construction.

[80] Agricultural terraces must be continually maintained and repaired. The labor involved in reconstruction and repair of a terrace wall corresponds approximately to the construction effort of initial terrace wall construction (Treacy 1994; Colman 1987:220).

6. Inka imperial metabolism

The calculations of labor and land embodied in Inka artifacts give an idea of the extent to which the Inka state and elite appropriated time and space from Andean commoners. In this final part, I will estimate the average ecological footprint of common Andean agro-pastoralists and use it together with the results from the case studies in an analysis of Inka imperial metabolism. This implies an understanding of imperialism not as a political process with ecological and social implications, but imperialism in itself as an ecological process (Hornborg 2016).

6.1 Reconceptualizing time as space

Since human labor is, from a biophysical perspective, just another form of energy conversion, it is plausible to reconceptualize labor in terms of land. There are several variables which make such estimates prone to a high degree of uncertainty. When it comes to human metabolism, we have learned from modern ecological footprint analysis that human footprints can vary dramatically depending on cultural subsistence strategies. While endosomatic human metabolism is relatively stable, that is, most humans digest around the same amount of calories per day, exosomatic consumption, that is, dissipation of resources not consumed within the human body, varies considerably between social groups, as does the amount of time and space embodied in different consumption goods. The high rate of consumption of fine textiles by the Inka elite, for instance, required substantial areas of land, and the reliance of *chicha* in the Inka imperial economy also had substantial implications for land requirements. In her study of *chicha* consumption in the Mantaro region during late prehispanic times Costin (2015:54) has estimated that consuming maize in the form of *chicha* will decrease the caloric value by

between 48 and 88 percent, thereby increasing land requirements in relation to caloric output significantly.

It is thus crucial to keep in mind that energetic considerations will not be the only, and probably rarely even the primary, factor governing decisions on land use. Particularly those who need not worry about getting their energetic requirements met, such as the Inka elite, will only indirectly be guided by energetic considerations. This, of course, should not be attributed to ignorance about the modern concept of energy, and a resulting "irrational" use of land – consider, for example, the vast areas required for growing coffee in our contemporary world, a commodity in high consumer demand but with practically zero caloric content. (In fact, the stimulating effect of coffee might actually speed up human metabolism.) Coca leaf in the Andes would have been a corresponding crop, hugely important in Inka social metabolism, but not directly for human energy requirements.

With all this said, the variation in the energy and land requirements of Inka subjects was probably relatively stable and consistent. Although Andean subsistence practices and lifestyles varied, and their ecological footprints accordingly, ecological footprints would not have varied to the extent that they do between some regions of the world today.

6.2 Prehispanic Andean ecological footprints

Several studies and estimates of ecological carrying capacity have been carried out in the Andes. Steward and Faron (1959:121) estimated that a family in the Inka Empire could be sustained on half an acre (0.2 ha). N. Cook (1981:24) interprets Steward and Faron's estimate to mean that each hectare could sustain up to twenty people. N. Cook (ibid.) himself believes a maximum of seven people could be sustained per hectare in the "High Civilization areas of the Americas". Browman (1974) estimated the carrying capacity (for camelids) of the highland puna region, and as previously mentioned, more recent studies of hectare yields have been made for the raised fields in the Titicaca region (Erickson 1988, 1992). These previous studies often assessed certain agricultural or productive systems as closed systems, not taking into account how the agricultural fields were embedded in larger regional systems. The method used here to estimate land

requirements, or ecological footprints, of Andean people differs in some respects from these previous approaches; for instance in considering not only the productive capacity of the agricultural areas themselves, but also the productive areas required to provide fertilizer and labor.

To estimate the average ecological footprint, of a subsistence agro-pastoralist in the Andean highlands, I have relied on studies of agricultural and agro-pastoral systems in the area. The figures derive mainly from Thomas' (1972) study of the energetics of the highland community of Nuñoa in the Puno district of modern day Peru, and from studies by D'Altroy (1992) and Hastorf (1983, 1993) in the Mantaro Valley. The studies should be reasonably representative of conditions during the Inka period. To estimate the average land requirements of Inka subjects, I thus base my calculations on studies of the agricultural and agro-pastoral systems in these contemporary highland communities, where an estimated 2/3 of the population incorporated into the Inka empire resided (D'Altroy 2002:35). I am assuming the land requirements in the remaining areas of the empire were comparable to those in the highland.

To estimate the average caloric output per unit of area, I use the mentioned studies by Hastorf, D'Altroy, and Thomas. Based on detailed investigations of modern agricultural practices as well as archaeological research in the Mantaro Valley, Hastorf (1983, 1993) has estimated optimal prehispanic yield per hectare of the different agricultural land-use zones (Hastorf 1993:158, Table 20).[81] The average caloric output for all agricultural land-use zones amounted to around 1.9 million kcal/ha/year.[82] Reducing this number by 25 percent to account for seed storage (D'Altroy 1992), the average yield was around 1.4 million kcal/ha/year.

D'Altroy (1992), largely basing his calculations on Hastorf's (1983) research, has calculated the agricultural productivity of the five-kilometer catchment

[81] The production zones identified are: Valley land, both irrigated and not; Fertile lowland valley; Low hillside, both irrigated and not, up to 3580 m; Extensive hillside between 3370-4000 masl; High elevation; and Non-arable *puna*, between 3800-4400 m in elevation used for grazing and fuel gathering (Hastorf 1993:123, Table 3).

[82] Hastorf's estimates are based on crop rotations with indigenous crops: Potatoes, maize, quinoa, beans, and Andean tubers.

around the Inka site of Hatun Xauxa in the Mantaro Valley.[83] According to D'Altroy (1992:159, Table 8.2), this area could have yielded 13,150 × 10^6 kcal (the figure is reduced by 25 percent to account for seed storage). By dividing this output by the total production area in D'Altroy's Table 8.2 (1992:158), which was 5,699 ha, the estimate of energetic or caloric value per hectare of agricultural area is calculated at 2.3 million kcal/ha/year.

Thomas (1972:157, Table 29) estimates a considerably higher caloric output per hectare cultivated area than Hastorf and D'Altroy. By cultivating potatoes and Andean grains (quinoa and *cañihua*), highland agriculture in Nuñoa provided a substantial caloric output. For potatoes, Thomas calculates 198,000 calories per 500 square meters, and for quinoa he gives the figure of 307,800 calories per 500 square meters. Per hectare the total average caloric output is then 5,058,000 kcal. Calculating 25 percent for seed storage would leave 5,058,000 × 0.75 = 3,793,500 ≈ 3.8 million kcal/ha/year.

While the study area in the Mantaro region, which Hastorf's and D'Altroy's studies are based on, is intensively cultivated, and was also relatively intensively cultivated in prehispanic times[84] (Hastorf 1993), agriculture in Nuñoa is much less intensive with longer periods of fallow (between 6-12 years). Based on these three estimates of yield per hectare of agricultural land, I will use an average of 2.5 million kcal/ha/year.[85] According to Thomas' (1972:1972:109, Table 15) studies of energetics in the highland community of Nuñoa, average caloric consumption per person was 1479 kcal (kilocalories) per day. If this figure is taken as representative of the average daily caloric consumption during the Inka period, then one hectare of

---

[83] The area includes three production zones: valley, hillslopes, and uplands. The crops grown are potato, maize, tuber (*mashwa*), quinoa, bean, bean and lupine (*talwi*), and periods of fallow. The area is generally considered to be intensively cultivated.

[84] Hastorf (1993:136-140) finds evidence of intensification in all identified land zones: irrigation infrastructure, raised and drained fields, terraces and lynchets (lynchets are earth-banked fields or terraces), and ridged fields.

85 Other experimental studies of the productivity of ancient production systems have given results which differ dramatically from this estimate. Experimental raised fields in the Titicaca area produced enough potatoes to support 37.5 persons/hectare of field surface/year (Erickson 1992:297, 1988). The fields produced on average 10 tons of potatoes per hectare, without use of fertilizer (Erickson 1988); it is unlikely, however, that such high productivity levels could be sustained continuously without periods of fallow and/or use of fertilizer.

agricultural land could sustain on average 2,500,000 / 1479 / 365 = 4.6 people per hectare.

To calculate the average labor requirements per hectare of this agricultural production, I use figures from Hastorf and Thomas. Hastorf (1993:158, Table 20) has estimated the production costs for every production zone identified in the Mantaro Valley. In eight different land zones a total of 729 days of labor were expended to cultivate one hectare. Divided by 8 (land zones) the average labor input was 91.125 labor days/ha/year.

Thomas (1972:117-8, Table 18), calculates the labor requirements for potatoes at 7,787 minutes per 500 square meters,[86] and for quinoa the labor requirements are calculated at 6,097 minutes per 500 square meters.[87] The total average labor requirements per hectare would then be (7,787 + 6,097) / 2 × 20 = 138,840 minutes = 2,314 hours. Assuming a labor day of 6.5 hours (Thomas 1972), this would equal 356 days/ha/year.

The average labor requirements in these two examples provided by Hastorf and Thomas are then (91.125 + 356) / 2 ≈ 224 labor days/ha/year. This is equivalent to 224 / 365 = 0.6 laborer. If we subtract this number from 4.6 (which is the (gross) number of people which can be sustained by one hectare of agricultural land), we see that 1 hectare of agricultural land can produce food for 4.6 - 0.6 = four additional people who have a capacity to produce (net) surplus labor equivalent to 4 people × 365 days × 7 hours[88] = 10,220 hours per year.

It is crucial to keep in mind here that this agricultural productivity could only be sustained with the use of fertilizer. Agriculture in the intensive form practiced during Inka times in many areas required fertilizer, and there are numerous descriptions of the use of fertilizer by the Inka in the early colonial

---

[86] The labor tasks included in this calculation are: (1) Field preparation and planting, stone removal, irrigation, foot plowing, breaking up clods, spreading dung, planting, walking to and from fields, transporting dung, transporting seed. (2) Weeding, ridging. (3) Harvesting, transporting harvest, sorting potatoes, making *chuño,* and seed storage (Data from Thomas 1972:117-8, Table 18).

[87] The labor tasks involved in this calculation are: (1) Field preparation and planting: raking, sowing, and walking. (2) Harvest: picking, threshing, walking, transporting harvest, winnowing, and grinding. (Data from Thomas 1972:118-9, Table 18).

[88] In my calculations I have defined standard average length of the labor day for different kinds of labor in the Andes to between six and eight hours a day. Therefore I calculate with an average of seven hours here.

sources (Denevan 1995) documenting its importance in the Inka economy. Guano was used on the coast and also imported inland transported by llama caravan (Julien 1985). Donkin (1979) mentions the use of fish as fertilizer, and Garcilaso has a description of the use of human manure by the Inka which is worth quoting at length:

> They fertilized the soil by manuring it, and in the valley of Cuzco and almost all the highland area they treated their maize fields with human manure, which they regarded as the best. They go to great trouble to obtain it, and dry it and pulverize it in time for the growing season (Garcilaso quoted in Sillar 2000a:63).

Another Inka fertilizer practice of *llakoshka*, was reported by Anonymous (1985), and is said to increase yields by 20 percent (Denevan 1995:32, see also Denevan 2001:38). The procedure is again worth quoting in full since it illustrates the sophistication of native Andean agricultural practices.

> Seeds are dipped into a putrefying and fermenting mixture of dried llama dung, salt, and *chicha* (maize beer), and sometimes juice from the fruit of the molle tree (*Schinus molle*). Resulting biochemical processes make inorganic elements in the soil more easily assimilated; parasites and aerobic organisms are destroyed; an anaerobic bloom is created; the dung provides nutrients for the seedlings and root system; yeast from the *chicha* turns seed starch to sugar which is advantageous to root development; plus there are other positive effects (Denevan 1995:32).

All of these fertilizer practices, using human manure, fish, green manure and so on, could have substituted some of the fertilizer requirements of llama dung and therefore of the pasture land requirements. Nevertheless they would still have demanded an input of labor and land, and I will use only camelid dung in my calculations of fertilizer requirements.

As we have seen in the *chicha* case study (Notes to Table 5.3.1, note b), camelids produce 209 kg of dung per hectare of pampa grazing area. Thomas (1972:166) reports from the highland community of Nuñoa that every crop rotation period (in Nuñoa crop rotation was usually potato, grain, grain, and a period of fallow between 2 and 12 years) required 1.8 kg of camelid dung per square meter. If we assume this fertilizer demand is required every third year in intensive agriculture (that is, with shorter periods of fallow which must be assumed for the primary agricultural zones (Hastorf 1993:130), then the average dung requirements per hectare of agricultural production would be

1.8 kg × 10,000 m^2/ha = 18,000 kg / 3 = 6,000 kg/year/hectare. Each hectare of agricultural land would therefore require 6,000 / 209 = 28.7 hectares of pampa grazing area.

If we assume that the dung provided by camelids grazing on *bofedal* pastures derives from higher levels of primary production, then one hectare of *bofedal* pasture could yield 1.75 ha / 0.63 ha = 2.77 × 209 kg = 580.6 kg of dung per hectare per year.[89] Through fertilizer requirements, intensive agricultural production thus embodied 28.7 hectares of pampa pasture or 6,000 kg / 580.6 kg = 10.3 hectares of *bofed*al pasture.

These grazing pastures could also have provided other useful resources, such as fleece and meat. Moreover, Thomas (1972:47-8) mentions that around 100 different kinds of herbs were gathered in Nuñoa. These herbs were probably nutritionally important even if they did not provide any significant caloric energy. Thomas (1972:161-162, Table 32 and 33) estimates that the caloric value of the edible portion[90] of a typical llama weighting 90 kg is 92,554 kcal. If we assume that a llama requires 1.75 ha of pasture land (see textile case study), and has an average life span of five years,[91] the caloric output of llama herding per hectare is: 92,554 × 0.20 / 1.75 = 10,578 kcal/ha/year. The calories produced through herding on pampa pasture could thus sustain 10,578 / 1,479 / 365 = 0.02 persons per hectare, which means that 50 hectares of camelid pastures would be required to sustain one person. Likewise a typical alpaca weighing 60 kg would provide 62,030 kcal (Thomas 1972:161, Table 32), and thus 62,030 kcal × 0.20 / 0.63 = 19,692.1 kcal/ha/year. *Bofedal* pastures could sustain 0.036 persons per hectare, which means that 28 hectares of *bofedal* pastures were required to sustain one person.

Using the data in the textile and *chicha* case studies we may deduce that one hectare of pampa pasture provided 1.5 kg / 1.75 ha = 0.86 kg of llama fleece, 209 kg of camelid dung, and 10,578 kcal of protein and fat. One hectare of

[89] Llamas are estimated to require 1.75 hectares of pampa pasture, while alpacas are estimated to require 0.63 ha of *bofedal* pasture (see Notes to Table 5.2.1, note a), whereas both llamas and alpacas are assumed to drop the same amount of dung per day.

[90] Meat, fat, brain, blood, heart, intestines, liver, lungs, and stomach.

[91] Thomas (1972) states that with an average death rate of 20 percent (15 percent slaughtered and 5 percent dying of natural causes) herds can be maintained, which means that the average life span of individual llamas is five years.

bofedal pasture yielded 2 kg / 0.63 ha = 3.2 kg of alpaca fleece, 580.6 kg of camelid dung, and 19,692.1 kcal.

Herding of course also demands labor input. Thomas' studies of labor expenditure in herding in Nuñoa has shown that daily herding activities plus the activities of shearing and slaughtering required 176,380 minutes per 100 animals (1972:119-120, Table 18). The area required to sustain 100 llamas and alpacas respectively is thus 100 × 1.75 ha = 175 ha of pampa pasture or 100 × 0.63 ha = 63 ha of *bofedal* pasture. The labor requirements involved in herding (+ shearing and slaughtering) are 176,380 minutes / 175 ha of pampa pasture / 60 = 16.8 hours per hectare and for *bofedal* pastures, the labor requirements are 176,380 / 63 ha / 60 = 46.7 hours per hectare.

Thomas (1972:116) states that in Nuñoa a normal day of herding involves 8 hours of active work (compared to agricultural labor, which typically involves 6.5 hours of active work). Pampa pastures therefore required 16.8 hours / 8 hours = 2.1 labor days/ha/year. *Bofedal* pastures required 46.7 hours / 8 hours = 5.8 labor days/ha/year.

Thus, one hectare of agricultural land can feed 4.6 / 0.02 = 230 times as many people as one hectare of pampa while requiring 2314 / 16.8 = 138 times as many labor hours. Similarly, one hectare of agricultural land can feed 4.6 / 0.036 = 128 times as many people as one hectare of *bofedal* pasture while requiring 2314 / 46.7 = 50 times as many labor hours.

These results are summarized in Table 6.1

Table 6.1
Output per hectare of pasture and agricultural land

1 hectare of agricultural land*: Produced calories to sustain 4.6 people (1,479 kcal per capita) Produced a surplus labor capacity of 10,220 hours Required 224 labor days, equivalent to 0.6 agricultural laborer *However, agricultural productivity also required fertilizer. Assuming camelid dung was the primary source of fertilizer, 1 ha of agricultural land embodied 28.7 ha of pampa land OR 10.3 ha of bofedal land.
1 hectare of pampa grazing land: Produced calories to sustain 0.02 people Produced 0.86 kg of llama fleece (enough to produce 0.6 awasqa tunic) Produced 209 kg of camelid dung (used as fertilizer and fuel) (sufficient to fertilize 0.034 ha of agricultural land) Required 16.8 hours of herding labor/year, or 2.1 labor days, equivalent to 0.0058 herder
1 hectare of bofedal grazing land: Produced calories to sustain 0.036 people Produced 3.2 kg of alpaca fleece (enough to produce 8.5 qompi tunics) Produced 581 kg of camelid dung (used as fertilizer and fuel) (sufficient to fertilize 0.1 ha of agricultural land) Required 46.7 hours of herding labor/year, or 5.8 labor days, equivalent to 0.016 herder

The figures in Table 6.1 can now be used to recalculate the labor embodied in the three Inka artifacts assessed in the case studies into space. Since one hectare of agricultural land has been estimated to produce a surplus of 10,220 labor hours, embodied labor is recalculated into space through the formula: space (ha) = embodied labor hours / 10,220

Table 6.2
Space embodied in Inka artifacts: Textiles, chicha and stone walls**

	Embodied land	Embodied labor recalculated into space	Percentage of labor requirements of total embodied space*
***Awasqa* textiles per tunic**	1.92 ha (pampa pasture)	233 hours = 0.023 ha (230 m^2) (agricultural land)	1%
***Qompi* textiles per tunic**	0.13 ha (bofedal pasture)	2,759 hours = 0.27 ha (2700m^2) (agricultural land)	68%*
Household *chicha* per year/household	15.8 ha	5,201 hours = 0.51 ha (5100m^2) (agricultural land)	3%
Ceremonial *chicha* per 6,000 liters	1.65 ha	4,642 hours = 0.46 ha (4600m^2) (agricultural land)	22%
Ashlar masonry per square meter		458 hours = 0.04 ha (400m^2) (agricultural land)	100%
Cyclopean masonry per square meter		708 hours = 0.07 ha (700m^2) (agricultural land)	100%
Fieldstone terrace wall per square meter		7.5 hours = 0.0007 ha (7m^2) (agricultural land)	100%

*Note that this calculation is based on area and does not take into consideration the difference in productivity of the different land-use zones.
**Note that the figures in Table 6.2 cannot be added together to provide a figure of total embodied land. To illustrate why this is the case we may take the example of an awasqa tunic which requires 1.92 ha of pampa pasture. Those hectares of pasture will also provide dung, which can be used as agricultural fertilizer or as fuel, and therefore cannot be added.

6.3 Productive capacity of Andean land-use zones

The most recent estimates of *bofedal* area in Peru today range between 509,381 and 549,360 hectares (Maldonado 2014:1; MINAM 2010, 2012) out of a total pasture area of 20,976,028 ha, or approximately 2.5 percent. Estimates of *bofedal* area in Bolivia are much lower (Alzérreca et al. 2001),[92] but the explanation for the discrepancy probably relates at least partly to differences in classification (estimates for *bofedal* area in Peru made by INRENA (1996) were much lower than the more recent, official estimates (MINAM 2010, 2012).

As illustrated in figure 6.1, the total area classified as natural pastures today, within the area believed to have been included in the Inka Empire, is 63.1 million hectares. If we extrapolate the ratio between pampa and *bofedal* pastures in modern day Peru (which is 2.5 percent) to the corresponding pasture areas within the Inka Empire, there would have been 63.1 × 0.025 = 1.58 million ha of *bofedal* and 63.1 × 0.975 = 61.5 million ha of pampa pasture land within the borders of Tawantinsuyu.

This is of course an estimate of the productive potential, not of actual land use during Inka times. Historical and archaeological documentation can, however, provide some clues as to which strategies the Inka state used to control and appropriate this potential, and to which extent they managed to do so. The Inka controlled the pasture areas by requiring communities to tend the Inka herds, and appropriating a large proportion of the fleece. Camelid dung was also essential in the imperial economy as we have seen. Another strategy used by the Inka to exploit the highland zones were the so-called *chaku* hunts, which were hunts aimed at harvesting wild animals. These hunts are mentioned by several of the chroniclers. It is not known how far back in time the practice of *chaku* went, but it is clear that the Inka sought to restrict its use, and that they made it into an Inka controlled ritual event (Dransart 2002). Garcilaso gives a description of these hunts and writes that they took place every four years in a given place. The Inka are said to have commanded up to forty thousand people on these hunts to gather wild animals; camelids, fox, deer, bear, puma etc. The wild camelids, guanaco and vicuña,[93] were

[92] Alzérreca et al. (2001:46-47, 166) report 102,340.7 ha bofedal area out of a total pasture area of 9,294,519.1 ha or 1.1 percent in Bolivia.

[93] Guanacos and vicuñas were classified as *intipllaman* i.e. camelids of the Sun. The llama and alpaca herds of the state and the cult were classified as *qhapacllama*, i.e. great or mighty,

sheared for their fleece, the largest and best males were released for breeding, while other selected animals were slaughtered and the meat distributed among the participants of the hunt (Dransart 2002:30). In this way, the Inka were able to exploit even marginal areas of their empire.

When it comes to determining the productive potential of agriculture in the Inka Empire, it is quite probable that the agricultural area in use at any particular time varied from year to year (Ramírez 2005). The information from the chroniclers suggests that production was accommodated to state needs, not to the available area of agricultural land. Since each day of agricultural labor could yield enough energy to sustain another 4 / 0.6 = 6.7 days of labor (see Table 6.1), increasing agricultural production was an efficient way to secure accelerating surplus production. Hastorf (1993:148) writes that productivity will tend to fall when agricultural activities and fields are located more than 5 kilometers from villages or settlement. Spreading the population will therefore also be a strategy to increase the agricultural output per labor input, something which appears to have been part of the rationale behind the *mitmaqkuna* strategy of the Inka state. Several sources document that labor obligations placed on households during Inka times encouraged large family size to manage both community fields and herds, as well as those of the Inka state and the Inka solar cult. Also, although it is often stated that the Inka reclaimed unused or abandoned lands for agricultural production, we should recall that every new hectare reclaimed for imperial agricultural production required not only the labor of reclaiming the land and constructing new landesque capital, but also a continual labor effort of on average 224 days of labor a year.

Modern estimates from Peru state that only 2 percent of the land surface is arable. Such estimates, however, cannot be considered applicable to prehispanic times. First of all, archaeological research has shown that the extent of arable land was greater in prehispanic times (Kosok 1965). Second, modern estimates tend to ignore "marginal" production zones. In a survey of the Cañete Valley, for example, Mayer and Fonseca (1979:8) found that actual agricultural area was 68,000 hectares or twice as large as the Peruvian National Office of Resource Evaluation (ONERN) had estimated (Mayer 2002:245; cf. Paulson 2005).

---

and the community herds were classified as *waqchallama*, "those of the weak" (Murra 1965:203).

As a baseline, I will therefore calculate the agricultural area required to sustain the Andean population, assuming no surplus production above metabolic needs. If we assume that the productivity of coastal agriculture approximately corresponded to the productivity calculated for the highlands, we may deduce from the results in Table 6.1 that an Andean population of 10 million people would require 10,000,000 / 4.6 = 2.2 million ha of agricultural land to sustain itself with energy. The labor requirements to produce this food could be fulfilled by 2.2 million people working 224 days a year, or roughly seven months. To secure enough fertilizer for sustained agricultural output would require 2.2 million / 0.034 ≈ 65 million ha of pampa pasture land, which corresponds roughly with the areas that are today classified as "natural pastures"[94] within the borders of Tawantinsuyu (see Figure 6.1). This area would simultaneously produce animal calories to sustain another 1.3 million people, and require the labor of 374,000 herders. The percentage of pasture area which were *bofedales* would have reduced the required pasture area slightly, but it shows that fertilizer, and therefore camelid herding, was more of a limiting factor to agriculture than human labor power, and it supports the hypothesis proposed by many that herding, or agro-pastoralism, was a much more widespread phenomenon than it is today, with camelid herding and pastoralism largely confined to elevations above 4000 m (Lane 2006; Flores Ochoa 1982).

The basic productive capacity of the three agro-pastoral land-use zones are summarized in Table 6.3

[94] These eco-zones are defined as *Páramo*, wet and dry *Puna*, and Southern Andean Steppe.

Table 6.3
Productive capacity of agro-pastoral land-use zones

2.2 million hectares of agricultural land*: Produced calories to sustain 10 million people (1,479 kcal per capita) Required 1.3 million (full time) agricultural laborers
61.5 million hectares of pampa grazing land:** Produced calories (in the form of camelid meat) to sustain 1.2 million people Produced 53,000 tons of llama fleece (enough to produce 33 million awasqa tunics) Produced 13 million tons of camelid dung (sufficient to fertilize 2.1 million hectares of agricultural land) Required 357,000 (full time) herders
1.58 million hectares of bofedal grazing land*:** Produced calories (in the form of camelid meat) to sustain 57,000 people Produced 5,000 tons of alpaca fleece (enough to produce 12 million qompi tunics) Produced 917,000 tons of camelid dung (sufficient to fertilize 0.15 million hectares of agricultural land) Required 25,000 (full time) herders

*Note that this is not an estimate of the actual extent of agricultural land in the Inka Empire, but the area which would have been required to sustain its population of an estimated 10 million people with caloric energy.
** Note that this is the estimated area of pampa pasture in modern times, within the borders of the Inka Empire.
*** Note that this is the estimated area of bofedal pastures in modern times within the borders of the Inka Empire.

Figure 6.1
Map of agro-pastoral land-use zones, illustrating Table 6.3. (On scale).

7. Results and conclusions

7.1 Material footprints of Inka artifacts

It is now possible to estimate the material or ecological footprints of certain Inka strategies and practices, and to assess how large a proportion of the Andean landscape was appropriated in the production of Inka textiles, *chicha,* and stone walls. The so-called textile tax required every household to produce one or two *awasqa* tunics annually for the state. In the textile case study it was conservatively estimated that this would amount to at least 1 million *awasqa* tunics every year. The ecological footprint of this production would be 1.92 million ha to produce the fleece, and 23,000 ha × 6,000 kg / 209 kg = 660,000 of those same hectares would be required to fertilize the 233 million hours / 10,220 = 23,000 ha of agricultural land required to sustain the textile labor. In total 1.92 million ha of pasture land and 23,000 ha of agricultural land.

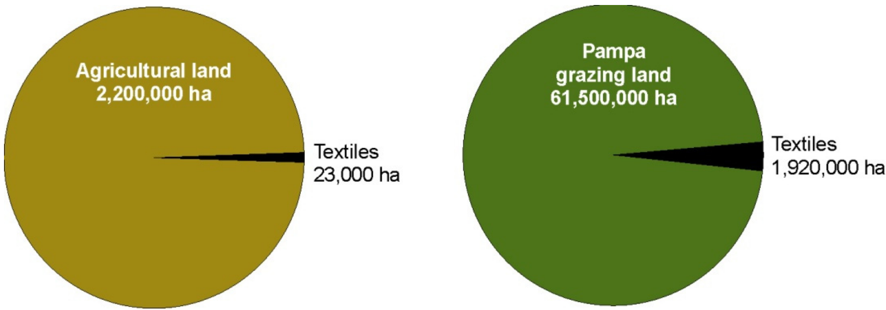

Figure 7.1
Space embodied in 1 million *awasqa* tunics.

The role of *chicha* in representing ecologically unequal exchange and capital accumulation can also be assessed: If 2.5 liters of a thick *chicha* brew was the main form in which *mit'a* labor was reciprocated by the Inka state, then the

ecological footprint of this phenomenon can be calculated. If we assume, as was done in the case study, that one million tributaries were served 2.5 liters of *chicha* every day for a period of two months,[95] or sixty days per year, it would have required 1 million × 2.5 liters × 60 days × 2.7 ha / 76 liter / 52 weeks = 0.102 million ha = 102,000 ha of agricultural land to produce the maize,[96] 102,000 × 28.7 ha = 2.9 million ha of pampa land for agricultural fertilizer, and an additional 1 million × 2.5 liters × 60 days × 13 ha / 76 liter / 52 weeks = 0.49 million ha of pampa land if the fuel used for cooking the *chicha* was llama dung.[97] The labor involved in producing the *chicha* would be 1 million × 2.5 liters × 60 days × 5,201 hours / 76 liter / 52 weeks = 197 million hours, which can be recalculated into space as 197 million hours / 10,220 hours = 19,000 ha of agricultural land. To sustain the herders of the 2.9 + 0.49 = 3.4 million hectares of pampa pastures, estimated to have required a total of 3.4 million × 16.8 hours = 57 million labor hours, would have required an additional 57 million hours / 10,220 hours = 5,600 ha of agricultural land. The total footprint of such imperial *chicha* production would then be 102,000 + 19,000 + 5,600 ≈ 127,000 ha of agricultural land and 2.9 million + 0.49 million = 3.4 million ha of pampa land.

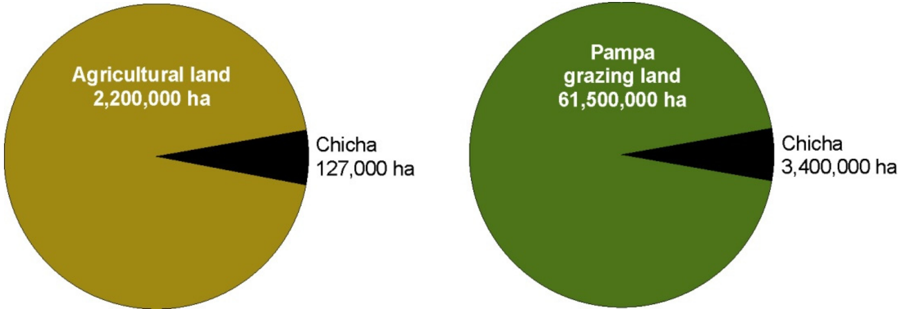

Figure 7.2
Space embodied in *chicha* to reciprocate for *mit'a* labor.

---

[95] The historical sources mention that the *mit'a* labor demanded from every tributary was two to three months every year.

[96] (see Example 5.3.1)

[97] Here I am adding the fuel and fertilizer requirements into a total footprint. I reality, the two footprints would overlap and thus be reduced since ashes of burnt fuel, wood and dung was undoubtedly used as fertilizer in prehispanic times as it is today (Johannessen and Hastorf 1990).

If we assume that 10 percent of the *mit'a* labor force, working sixty days every year, 6 hours a day, was devoted to stonework,[98] then this labor force of 100,000 thousand men could be kept working on 10 percent of the total *chicha mit'a* footprint, or 127,000 × 0.1 = 12,700 ha of agricultural land and 3.4 × 0.1 = 340,000 ha of pampa land. At this imperial expense, the *mit'a* stone masons could have constructed 100,000 × 60 days × 6 hours / 458 = 78,600 m^2 of ashlar masonry, or 100,000 × 60 days × 6 hours / 708 = 51,000 m^2 of cyclopean masonry, or 100,000 × 60 days × 6 hours / 7.5 = 4.8 million m^2 of terrace retaining wall, corresponding to 4.8 million × 5 / 10,000 = 2,400 ha of terraced land.

In the case study of stone walls, it was estimated that the stone labor involved in constructing and maintaining the estimated terraced area in the Inka Empire was 300 million hours per year. The space embodied would thus be 300 million hours / 10,220 hours ≈ 29,000 ha of agricultural land.

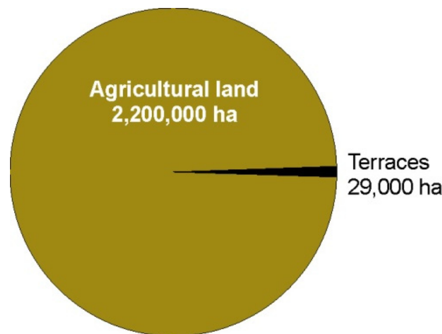

Figure 7.3
Space embodied in terrace retaining walls.

It is thus possible to estimate, by and large, the input of labor and land required to produce various forms of imperial capital. It is also possible to estimate how much capital, in the form of textiles, *chicha* and stone walls, could be accumulated for every hectare of agricultural land.

In Table 6.1 it was estimated that one hectare of agricultural land could provide for 4.6 – 0.6 = 4 person-year equivalents ≈ 10,220 hours of surplus labor. Here we should, however, take into account that 1 ha of agricultural

[98] This is the percentage of the Chupachu working as "Masons in Cuzco" according to the Chupachu *visita* (Julien 1988:265).

land also required dung from 28.7 ha of pampa grazing land, which again required 16.8 labor hours × 28.7 = 482 hours. If this is subtracted from the 10,220 hours, we get the surplus labor from each hectare of agricultural land to be 10,220 – 482 = 9,738 hours. This surplus labor could be converted into, for instance, 9,738 / 233 = 42 *awasqa* tunics or 9,738 / 2,759 = 3.5 *qompi* tunics. Since a weekly batch of 76 liters of *chicha* (3,952 liters per year) would require 5,201 hours (see Table 5.3.1) one hectare of agricultural land could provide 9,738 / 5,201 × 3,952 = 7,399 liters of thick household *chicha*, or 9,738 / 4,642 × 6,000 liters = 12,587 liters of ceremonial *chicha* (see Table 5.3.2). Likewise, one hectare of agricultural land could provide labor to construct 9,738 / 458 = 21 square meters of ashlar masonry wall, or 9,738 / 708 = 13.8 square meters of cyclopean masonry, or 9,738 / 7.5 = 1,298 square meters of terrace retaining wall. These results are summarized in Table 7.1

Table 7.1
Surplus labor per hectare of agricultural land*

***Awasqa* cloth**	42 tunics
***Qompi* cloth**	3.5 tunics
Household *chicha*	7,399 liters
Ceremonial *chicha*	12,587 liters
Ashlar masonry	21 m^2
Cyclopean masonry	13.8 m^2
Terrace retaining wall	1,298 m^2

* Note that each row represents what could be provided by one hectare of agricultural land – the different artifacts cannot be added together.

7.2 Concluding remarks

Time and space may arguably be considered universal economic metrics; what all humans have in common is that the extension of their life can be measured in time. And equally universal is the fact that this life time requires space. Conceptualizing economy as transfer of time and space between people, using the method of time-space appropriation analysis, it has been demonstrated that it is possible to calculate how much time and space the Inka appropriated from their subjects, as has been done in this thesis, on the basis of archaeological, historical and ethnographic data.

Estimates of how much land and labor was embodied in Inka artifacts have been listed in the case study tables; two types of cloth, two types of *chicha*, and three types of stone walls, and the function of these artifacts in the Inka political economy has likewise been discussed. These artifacts were thus embodiments of the unequal power relations between those who were identified as Inka and those who were not. It has been shown that for every *qompi* tunic, every extra liter of *chicha,* or every meter of wall, the Inka economy "grew", in reality this growth, or accumulation of capital, consisted in the appropriation of a certain measure of the time in the lives of Inka subjects, and a certain measure of ecological space. It has been demonstrated that increased surplus production, which is often described and understood as deriving from organizational or technological change, is often, in biophysical terms, simply the result of increased appropriation of labor and land.

Imperial power, as exemplified in this thesis by the Inka, thus consists in the biophysical/material flows controlled and appropriated by an imperial elite, and the cultural representation of these flows as balanced, fair, natural and inevitable. This ecological process involves not only the creation of "things" such as textiles, *chicha* and stone walls, and the transformation of landscapes, but also the creation of different kinds of people.

8. References

Abercrombie, T.A. 1998. *Pathways of Memory and Power: Ethnography and History among an Andean People*. Wisconsin: University of Wisconsin Press.

Acuto, F.A. 2011. "Landscapes of Inequality, Spectacle and Control: Inka Social Order in Provincial Contexts." With comments by Sonia Alconini, Gabriel Cantarutti, R. Alan Covey, Ian Farrington, Martti Pärssinen and Simón Urbina. *Revista Chilena de Antropología* 25:9-64.

Agurto Calvo, S. 1987. *Estudio Acerca de la Construcción Arquitectura y Planeamiento Incas*. Lima: Cámara Peruana de la Construcción.

Alberti, G., and Mayer, E. 1974. *Reciprocidad e Intercambio en los Andes Peruanos*. Lima, Peru: Instituto de Estudios Peruanos.

Allen, C.J. 1998. "When Utensils Revolt: Mind, Matter, and Modes of Being in the Pre-Columbian Andes." *RES: Anthropology and Aesthetics* 33:18-27.

Allen, C.J. 2002[1988]. *The Hold Life Has: Coca and Cultural Identity in an Andean Community.* Second Edition. Washington: Smithsonian Books.

Altvater, E. 1994. "Ecological and Economic Modalities of Time and Space." In (ed.) O'Connor, M. *Is Capitalism Sustainable? Political Economy and the Politics of Ecology.* New York: The Guilford Press.

Alzérreca, H., Prieto, G., Laura, J., Luna, D. and Laguna, S. 2001. *Características y Distribución de lo Bofedales en el Ambito Boliviano*. Informe Final. Subcontrato 21. La Paz, Bolivia.

Ames, K.M. 2010. "On the Evolution of the Human Capacity for Inequality and/or Egalitarianism" In (eds.) Price, T.D., and Feinman, G.M. *Pathways to Power: New Perspectives on the Emergence of Social Inequality*. New York: Springer, pp. 15-44.

Anderson, K. 2009. "Tiwanaku Influence on Local Drinking Patterns in Cochabamba, Bolivia." In (eds.) Jennings, J., and Bowser, B. *Drink, Power, and Society in the Andes.* Gainesville: University Press of Florida, pp. 167-199.

Anonymous 1985. "Centuries-old fertilizer formula survives in Peru." *Ceres* 107:8.

Appadurai, A. 1986. "Introduction: Commodities and the Politics of Value". In (ed.) Appadurai, A. *The Social Life of Things: Commodities in Cultural Perspective*. Cambridge: Cambridge University Press, pp. 3-63.

Araujo, H. 1987. “Civilización Andina: Acondicionamiento Territorial y Agricultura Prehispánica. Hacia una Revaloración de su Technología.” In (eds.) Torre, C., and Burga, M. *Andenes y Camellones en el Peru Andino: Historia, Presente y Futuro*. 2. Ed. Lima: Consejo nacional de ciencia y technología Concytec, pp. 277-300.

Arnold, D.Y., and Hastorf, C.A. 2008. *Heads of State: Icons, Power, and Politics in the Ancient and Modern Andes*. Walnut Creek, California: Left Coast Press.

Aveni, A.F. 1992. “Pre-Columbian Images of Time” In (ed.) Townsend, R. *The Ancient Americas: Art from Sacred Landscapes.* The Art Institute of Chicago, pp. 49-59.

Aveni, A.F. 2002. *Empires of Time: Calendars, Clocks, and Cultures*. Revised Edition. Boulder, Colorado: University Press of Colorado.

Balée, W.L., and Erickson, C.L. 2006. *Time and Complexity in Historical Ecology: Studies in the Neotropical Lowlands*. New York: Columbia University Press.

Barber, E.W. 1995. *Women's Work: The First 20,000 Years Women, Cloth, and Society in Early Times*. WW Norton & Company.

Baudin, L. 1961[1928]. *A Socialist Empire: The Incas of Peru*. Translated by Katherine Wood. Princeton: Van Nostrand.

Bauer, B.S. 2006. “Suspension Bridges of the Inca Empire.” In (eds.) Isbell, W. H. and Silverman, H. *Andean Archaeology III.* New York: Springer, pp. 468-493.

Bauer, B.S., and Dearborn, D.S.P. 1995 *Astronomy and Empire in the Ancient Andes: the Cultural Origins of Inca Sky Watching*. Austin: University of Texas Press.

Bauer, B.S., and Smit, D.K. 2015. “Separating the Wheat from the Chaff: Inka Myths, Inka Legends, and the Archaeological Evidence for State development.” In (ed.) Shimada, I. *The Inca Empire: A Multidisciplinary Approach*. Austin: University of Texas Press, pp. 67-80.

Beresford-Jones, D.G., Torres, S.A., Whaley, O.Q., and Chepstow-Lusty, A.J. 2009. “The Role of Prosopis in Ecological and Landscape Change in the Samaca Basin, Lower Ica Valley, South Coast Peru From the Early Horizon to the Late Intermediate Period.” *Latin American Antiquity* 20(2):303-332.

Bender, B. 2002. “Time and Landscape.” *Current Anthropology* 43(S4):103-112.

Bengtsson, L. 1998a. *Prehistoric Stonework in the Peruvian Andes: A Case Study of Ollantaytambo*. Doctoral dissertation. Göteborg University, Department of Archaeology.

Bengtsson, L. 1998b. “The Concept of Time/Space in Quechua: Some Considerations.” In (eds.) Algren, S., Muñoz, A., Sjödin, S., and Stenborg, P. *Past and Present in Andean Prehistory and Early History*. Proceedings of a workshop held at the Etnografiska museet, Göteborg, Seden, September 16-17, 1996, pp. 119-127.

Benitez, L. 2009. “Descendants of the Sun: Calendars, Myth, and the Tiwanaku State.” In (ed.) Young-Sánchez, M. *Tiwanaku. Papers from the 2005 Mayer Center Symposium at the Denver Art Museum.* Denver: Denver Art Museum, pp. 49-81.

Betanzos, J.D. 1996[1551]. *Narrative of the Incas*. Translated and edited by Roland Hamilton and Dana Buchanan. Austin: University of Texas Press.

Bird, J.B. 1969. “Handspun Yarn Production Rates in the Cuzco Region of Peru.” *Textile Museum Journal* 2:9-16.

Bird, J.B. 1979. “Fibers and Spinning Procedures in the Andean Area.” In (eds.) Rowe, A. P., Benson, E. P., and Schaffer, A-L. *The Junius B. Bird Pre-Columbian Textile Conference.* Washington D. C.: The Textile Museum, Dumbarton Oaks, pp. 13-17.

Bogadóttir, R. 2012. “Fleece: Imperial metabolism in the Precolumbian Andes.” In (eds.) Hornborg, A., Clark, B., and Hermele, K. *Ecology and Power: Struggles over Land and Material Resources in the Past, Present and Future*. London: Routledge, pp. 83-96.

Bonavia, D. 2000. “The Role of the Ceja de Selva in the Cultural Development of Pre-Columbian Peru.” In (ed.) Minelli, L. *The Inca World: The Development of Pre-Columbian Peru, A.D. 1000-1534*. University of Oklahoma Press: Norman, pp. 121-131.

Bonavia, D. 2008. *The South American Camelids*. An Expanded and Corrected Edition. Cotsen Institute of Archaeology Monograph 64, Los Angeles, CA: University of California.

Bonavia, D. 2013. *Maize: Origin, Domestication, and its Role in the Development of Culture*. Cambridge: Cambridge University Press.

Booth, W.J. 1991. “Economies of Time: On the Idea of Time in Marx’s Political Economy.” *Political Theory* 19(1):7-27.

Boserup, E. 2005[1965]. *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure*. With a foreword by Virginia Deane Abernethy. New Jersey: Transaction Publishers.

Bouysse-Cassagne, T. 1986. “Urco and uma: Aymara concepts of space.” In (eds.) Murra, J.V., Wachtel, N., and Revel, J. *Anthropological History of Andean Polities*. Cambridge: Cambridge University Press, pp. 201-227.

Boytner, R. 2004. “Clothing the Social World.” In (ed.) Silverman, H. *Andean Archaeology*. Blackwell Studies in Global Archaeology, Malden, USA: Blackwell Publishing Ltd, pp. 130-145.

Bray, T.L. 2003. “Imperial Pottery, Commensal Politics, and the Inca State.” In (ed.) Bray, T. L. *The Archaeology and Politics of Food and Feasting in Early States and Empires*. New York: Kluwer Academic/Plenum Publishers, pp. 93-142.

Bray, T.L. 2009a. "An Archaeological Perspective on the Andean Concept of Camaquen: Thinking Through Late Pre-Columbian Ofrendas and Wak'as." *Cambridge Archaeological Journal* 19(3):357-366.

Bray, T.L. 2009b. "The Role of Chicha in Inca State Expansion: A Distributional Study of Inca *Aríbalos*" in (eds.) Jennings, J., and Bowser, B. *Drink, Power, and Society in the Andes*. Gainesville: University Press of Florida, pp. 108-132.

Bray T.L. 2012. "Ritual Commensality between Human and Non-Human Persons: Investigating Native Ontologies in the Late Pre-Columbian Andean World." In (ed.) Pollock, S. *Between Feasts and Daily Meals: Towards an Archaeology of Commensal Spaces*. eTopoi. Journal for Ancient Studies. Special Volume 2, pp. 197-212.

Browman, D.L. 1974. "Pastoral Nomadism in the Andes." *Current Anthropology* 15(2):188-196.

Brush, S.B. 1977. *Mountain Field and Family: The Economy and Human Ecology of an Andean Valley.* Philadelphia: University of Pennsylvania Press.

Burger, R.L. 1992. *Chavín and the Origins of Andean Civilization*. London: Thames and Hudson.

Burger, R.L. 2008. "Chavín de Huántar and Its Sphere of Influence." In (eds.) Silverman, H., and Isbell, W. H. *Handbook of South American Archaeology*. New York: Springer, pp. 681-703.

Burger, R.L., and van der Merwe, N. 1990. "Maize and the origin of Highland Chavín Civilization: An Isotopic Perspective." *American Anthropologist* 92:85-95.

Castillo Butters, L.J., and Uceda Castillo, S. 2008. "The Mochicas." In (eds.) Silverman, H., and Isbell, W. H. *Handbook of South American Archaeology*. New York: Springer, pp. 707-730.

Castillo Butters, L.J., Rucabado, J., Carpio, M., Bernuy, K., Ruiz, K., Rengifo, C., Prieto, G. & Fraresso, C. 2008. "Ideología y Poder en la Consolidación, Colapso y Reconstitución del Estado Mochica del Jequetepeque: El Proyeco Arqueológico San José de Moro (1991-2006)." *Ñawpa Pacha* 29(1):1-86.

Cereceda, V. 1986. "The semiology of Andean textiles" In (eds.) Murra, J. V., Wachtel, N., and Revel, J. *Anthropological History of Andean Polities.* Cambridge: Cambridge University Press, pp. 149-173.

Cieza de León, P. 1967[1551]. *El Señorio de los Incas.* Lima: Instituto de Estudios Peruanos.

Cleary, D. 2001. "Towards an Environmental History of the Amazon: From Prehistory to the Nineteenth Century." *Latin American Research Review* 36(2):64-96.

Cobo, B. 1979[1653]. *History of the Inca Empire*. Translated and edited by Roland Hamilton. Foreword by John Rowe. Austin: Texas University Press.

Cobo, B. 1990[1653]. *Inca Religion and Customs*. Translated and edited by Roland Hamilton. Austin: University of Texas Press.

Colman, B. 1987. “Problemática de la Recuperación de Andenes: el Caso de la Comunidad de Pusalaya (Puno).” In (eds.) Torre, C., and Burga, M. *Andenes y Camellones en el Peru Andino: Historia, Presente y Futuro*. 2. Ed. Lima: Consejo nacional de ciencia y technología Concytec, pp. 217-224.

Cook, N.D. 1981. *Demographic Collapse: Indian Peru, 1520-1620*. Cambridge: Cambridge University Press.

Cook, O.F. 1925. "Peru as a center of domestication tracing the origin of civilization through the domesticated plants." *Journal of Heredity* 16(3): 95-110.

Costin, C.L. 1993. “Textiles, Women, and Political Economy in Late Prehispanic Peru.” *Research in Economic Anthropology* 14:3-28.

Costin, C.L. 1998a. “Housewives, Chosen Women, and Skilled Men: Cloth Production and Social Identity in the Late Prehispanic Andes.” In (eds.) Costin, C.L., and Wright, R.P. *Craft and Social Identity*. Archeological Papers of the American Anthropological Association 8(1):123-141.

Costin, C.L. 1998b. “Introduction: Craft and Social Identity” In (eds.) Costin, C.L., and Wright, R.P. *Craft and Social Identity*. Archeological Papers of the American Anthropological Association 8(1):3-16.

Costin, C.L. 2015. “The Cost of Conquest” In (eds.) Morehart, C. T., and De Lucia, K. *Surplus: The Politics of Production and the Strategies of Everyday Life.* Boulder, Colorado: University Press of Colorado, pp. 45-72.

Costin, C.L., and Hagstrum, M.B. 1995. “Standardization, Labor Investment, Skill, and the Organization of Ceramic Production in Late Prehispanic Peru.” *American Antiquity* 60(4):619-639.

Covey, A.R. 2003. “A Processual Study of Inka State Formation*.” Journal of Anthropological Archaeology* 22:333-357.

Covey, A.R. 2008. “The Inca Empire.” In (eds.) Silverman, H., and Isbell, W. H. *Handbook of South American Archaeology*. New York: Springer, pp. 809-830.

Crumley, C.L. 1994. *Historical Ecology: Cultural Knowledge and Changing Landscapes*. Santa Fe: School of American Research Press.

Cummins, T.B.F. 2015. “Inka Art.” In (ed.) Shimada, I. *The Inca Empire: A Multidisciplinary Approach*. Austin: University of Texas Press, pp. 165-196.

Cunow, H. 1896. *Die Soziale Verfassung des Inkareisches* [The Social Constitution of the Inca Empire]. Stuttgart, J.H.W. Dietz.

Cutler, H.C., and Cadenas, M. 1947. “Chicha, a Native South American Beer.” *Botanical Museum Leaflets* Harvard University 13(3):33-60.

D’Altroy, T.N. 1992. *Provincial Power in the Inka Empire*. Washington, D.C.: Smithsonian Institution Press.

D’Altroy, T.N. 2002. *The Incas*. Malden, USA: Blackwell Publishing.

D’Altroy, T.N. 2015. “Funding the Inka Empire.” In (ed.) Shimada, I. *The Inca Empire: A Multidisciplinary Approach*. Austin: University of Texas Press, pp. 97-118.

D’Altroy, T., and Earle, T.K. 1985. Staple Finance, Wealth Finance, and Storage in the Inka Political Economy.” [With comments]. *Current Anthropology* 26(2):187-206.

Dean, C. 2010. *A Culture of Stone: Inka Perspectives on Rock*. Durham and London: Duke University Press.

Dedenbach-Salazar Sáenz, S. 2006. “Pacha: Space and Time in the Huarochirí Manuscript.” In (ed.) Dransart, P. *Kay Pacha: cultivating earth and water in the Andes*. BAR International Series 1478:19-28.

De la Cadena, M. 2015. *Earth Beings: Ecologies of Practice across Andean Worlds*. Durham, NC.: Duke University Press.

DeMarrais, E., Castillo Butters, L.J., and Earle, T. 1996. “Ideology, Materialization, and Power strategies.” *Current anthropology* 37(1):15-31.

Denevan, W.M. 1982. “Hydraulic Agriculture in the American Tropics: Forms, Measures and Recent Research.” In (ed.) Flannery, K.V. *Maya Subsistence.* New York: Academic Press, pp. 181-204.

Denevan, W.M. 1987. “Abandono de Terrazas en el Peru Andino: Extension, Causas y Porpuestas de Restauracion” In (eds.) Torre, C., and Burga, M. *Andenes y Camellones en el Peru Andino: Historia, Presente y Futuro.* 2. Ed. Lima: Consejo nacional de ciencia y technología Concytec, pp. 255-258.

Denevan, W.M. 1992. *The Native Population of the Americas in 1492*. Second Edition, Madison: The University of Wisconsin Press.

Denevan, W.M. 1995. “Prehistoric Agricultural Methods as Models for Sustainability.” In (eds.) Andrews, J.H., and Tommerup, I. *Advances in Plant Pathology*. London: Academic Press Limited.

Denevan, W.M. 2001. *Cultivated Landscapes of Native Amazonia and the Andes*. Oxford: Oxford University Press.

Desrosiers, S. 1986. “An Interpretation of Technical Weaving Data Found in an Early 17th-Century Chronicle.” In (ed.) Rowe, A. P. *The Junius B. Bird Conference on Andean Textiles*. April 7 and 8, 1984. Washington D.C.: The Textile Museum.

Dieterich, H. 1982. “Some Theoretical and Methodological Observations about the Inca Empire and the Asiatic Mode of Production.” *Latin American Perspectives* 9(4):111-132.

Dietler, M. 1990. “Driven by Drink: the Role of Drinking in the Political Economy and the Case of Early Iron Age France.” *Journal of Anthropological Archaeology* 9(4):352-406.

Dietler, M. 2001. “Theorizing the feast: rituals of consumption, commensal politics, and power in African contexts.” In (eds.) Dietler, M., and Hayden, B. *Feasts: Archaeological and Ethnographic Perspectives on Food, Politics, and Power*. Washington, DC: Smithsonian, pp. 65–114.

Dietler, M. 2006. “Alcohol: anthropological/archaeological perspectives.” *Annual Review of Anthropology* 35:229-249.

Dietler, M., and Herbich, I. 2001. “Feasts and labor mobilization: dissecting a fundamental economic practice.” In (eds.) Dietler, M., and Hayden, B. *Feasts: Archaeological and Ethnographic Perspectives on Food, Politics, and Power*. Washington, DC: Smithsonian, pp. 240-264.

Dietler, M., and Hayden, B. (eds.) 2001. *Feasts: Archaeological and ethnographic perspectives on Food, Politics, and Power*. University of Alabama Press.

Dillehay, T.D. 2003. “El Colonialismo Inka, El Consumo de Chicha y Los Festines Desde Una Perspective de Banquetes Políticos” In (eds.) Kaulicke, P., Urton, G., and Farrington, I. *Identidad y transformación en el Tawantinsuyu y en los Andes Coloniales. Perspectivas Arqueológicas y Etnohistóricas. Segunda parte. Boletín de Arqueología PUCP* 7:355-363.

Donkin, R.A. 1979. *Agricultural Terracing in the Aboriginal New World*. Tucson, Arizona: The University of Arizona Press.

Doolittle, W.E. 1984. “Agricultural Change as an Incremental Process.” *Annals of the Association of American Geographers* 74(1):124-137.

Dransart, P. 2002. *Earth, Water, Fleece and Fabric: an Ethnography and Archaeology of Andean Camelid Herding*. London: Routledge.

Dwyer, E.B. 1979. “Early Horizon Tapestry from South Coastal Peru.” In (eds.) Rowe, A. P., Benson, E. P., and Schaffer, A-L. *The Junius B. Bird Pre-Columbian Textile Conference.* Washington D. C.: The Textile Museum, Dumbarton Oaks, pp. 61-75.

Earle, T.K. 1980. “A Model of Subsistence Change.” In (eds.) Earle, T.K., and Christenson, A.L. *Modeling Change in Prehistoric Subsistence Economies.* New York: Academic Press, pp. 1-29.

Earle, T.K. 2002. *Bronze Age Economics: The Beginnings of Political Economies*. Boulder, Colorado: Westview Press.

Erickson, C.L. 1988. “Raised Field Agriculture in the Lake Titicaca Basin: Putting Ancient Andean Agriculture Back to Work.” *Expedition* 30(3):8-16.

Erickson, C.L. 1992. “Prehistoric Landscape Management in the Andean Highlands: Raised Field Agriculture and its Environmental Impact.” *Population and Environment: A Journal of Interdisciplinary Studies* 13(4):285-300.

Erickson, C.L. 2008. “Amazonia: The Historical Ecology of a Domesticated Landscape” In (eds.) Silverman, H., and Isbell, W. H. *Handbook of South American Archaeology*. New York: Springer, pp. 157-183.

Espinoza, W. 2008. “Economía política y domestica del Tahuantinsuyo.” In (eds.) Lumbreras, L. G., Kaulicke, P., Santillana, J. I., and Espinoza, W. *Economía Prehispanica*. Lima: Instituto de Estudios Peruanos, pp. 315-426.

Estete, M.D. 1968[1535]. Noticia del Perú. *Biblioteca Peruana*. Primera serie. Lima: Editores Técnicos Asociados 1:345-404

Fabian, J. 2002[1983]. *Time and the Other: How Anthropology Makes its Object*. New York: Columbia University Press.

FAO. 2003. *Maize: Post-harvest Operations*. (Ed.) Mejía, D. Food and Agriculture Organization of the United Nations.

Fischer-Kowalski, M. 1998. “Society’s Metabolism: The Intellectual History of Material Flow analysis.” *Journal of Industrial Ecology* 2(1):61-78.

Fischer-Kowalski, M., and Haberl, H. 1997. "Tons, joules, and money: Modes of production and their sustainability problems." *Society & Natural Resources* 10(1):61-85.

Fischer-Kowalski, M., and Haberl, H. (eds.) 2007. *Socioecological Transitions and Global Change: Trajectories of Social Metabolism and Land Use.* Cheltenham, UK/Northhampton, US: Edward Elgar.

Flores Ochoa, J.A. 1975. “Sociedad y Cultura en la Puna Alta de Los Andes.” *America Indigena* 35(2):297-319.

Flores Ochoa, J.A. 1977a. “Pastores de Alpacas de los Andes”, In (ed.) Flores Ochoa, J. A. *Pastores de Puna Uywamichiq Punarunakuna.* Lima, Peru: Instituto de Estudios Peruanos.

Flores Ochoa, J.A. 1977b. ”Enqa, enqaychu, illa y khuya rumi.” In (ed.) Flores Ochoa, J. A. *Pastores de Puna Uywamichiq Punarunakuna.* Lima, Peru: Instituto de Estudios Peruanos, pp. 211-237.

Flores Ochoa, J.A. 1982 “Causas que Originaron la Actual Distribución Espacial de las Alpacas y Llamas.” In (eds.) Milliones, L., and Tomoeda, H. *El Hombre y su Ambiente en los Andes Centrales*. Osaka: National Museum of Ethnology.

Frank, A.G. 1967. *Capitalism and underdevelopment in Latin America*. New York: New York University Press.

Frank, A.G. 1979. *Dependent Accumulation*. New York: New York University Press.

Franquemont, E. M. 1986. “Cloth Production Rates in Chinchero, Peru.” In (eds.) Rowe, A. P., Benson, E. P., and Schaffer, A-L. *The Junius B. Bird Pre-Columbian Textile Conference.* Washington D. C.: The Textile Museum, Dumbarton Oaks, pp. 309-330.

Gade, D.W. 1999. *Nature and Culture in the Andes*. Madison, Wisconsin: The University of Wisconsin Press.

Garcilaso de la Vega, E. 1966[1609]. *Royal Commentaries of the Incas*. Translated by Harold V. Livermore. Austin: University of Texas Press.

Gasparini, G., and Margolies, L. 1980. *Inca Architecture.* Bloomington: Indiana University Press.

Gayton, A.H. 1967. ”The Cultural Significance of Peruvian Textiles; Production, Function, Aesthetics.” In (eds.) Rowe, J. H., and Menzel, D. *Peruvian Archaeology: Selected Readings.* (Fifth Printing 1973). California: Peek Publications, pp. 275-292.

Gelles, P.H. 1995. “Equilibrium and Extraction: Dual Organization in the Andes.” *American Ethnologist* 22(4):710-742.

Georgescu-Roegen, N. 1999[1971]. *The Entropy Law and the Economic Process*. Cambridge, Massachusetts: Harvard University Press.

Georgescu-Roegen, N. 1986. “The Entropy Law and the Economic Process in Retrospect.” *Eastern Economic Journal* 12(1):3-25.

Gero, J. 1990. “Pottery, Power and Parties! At Queyash, Peru.” *Archaeology Magazine* (March- April):52-55.

Ghezzi, I., and Ruggles, C. 2007. “Chankillo: A 2300-Year-Old Solar Observatory in Coastal Peru.” *Science* 315(5816):1239-1243.

Ghezzi, I. 2008. “Religious Warfare at Chankillo.” In (eds.) Isbell, W. H., and Silverman, H. *Andean Archaeology III.* New York: Springer, pp. 67-84.

Giljum, S., Bruckner, M., and Martinez, A. 2015. “Material Footprint Assessment in a Global Input-Output Framework.” *Journal of Industrial Ecology* 19(5):792-804).

Girardin, C.A.J., Espejob, J.E., Doughty, C.E., Huasco, W.H., Metcalfe, D.B., Durand-Baca, L., Marthews, T.R., Aragao, L.E., Farfán-Rios, W., García-Cabrera, K., and Halladay, K. 2014. “Productivity and carbon allocation in a tropical montane cloud forest in the Peruvian Andes*.” Plant Ecology & Diversity* 7(1-2):107-123.

Glowacki, M., and Malpass, M. 2003. “Water, huacas, and ancestor worship: Traces of a sacred Wari landscape.” *Latin American Antiquity* 14(4):431-448.

Godelier, M. 1974. “The Definition of a Social Formation. The Example of the Incas.” *Critique of Anthropology* 1:63-75.

Godelier, M. 1977. *Perspectives in Marxist Anthropology*. Cambridge: Cambridge University Press.

Godelier, M. 1986. *The mental and the material: thought economy and society*. London: Verso.

Goldstein, P.S. 2003. “From Stew-Eaters to Maize-Drinkers: The *Chicha* Economy and the Tiwanaku Expansion.” In (ed.) Bray, T. L. *The Archaeology and Politics of Food and Feasting in Early States and Empires*. New York: Kluwer Academic/Plenum Publishers, pp. 143-172.

Goldstein, D.J., and Coleman, R.C. 2004 “Schinus molle L. (Anacardiaceae) Chicha Production in the Central Andes.” *Economic Botany* 58(4):523-529.

Goldstein, D.J., Goldstein, R.C.C., and Williams, P.R. 2009 “You are what you Drink: A Soiciocultural Reconstruction of Pre-Hispanic Fermented Beverage Use at Cerro Baul, Moquegua, Peru.” In (eds.) Jennings, J., and Bowser, B. *Drink, Power, and Society in the Andes.* Gainesville: University Press of Florida, pp 133-166.

Goodman-Elgar, M. 2009. “Places to Partake: *Chicha* in the Andean Landscape.” In (eds.) Jennings, J., and Bowser, B. *Drink, Power, and Society in the Andes.* Gainesville: University Press of Florida, pp. 75-107.

Gose, P. 1994. *Deathly Waters and Hungry Mountains: Agrarian Ritual and Class Formation in an Andean Town*. Toronto: Toronto University Press.

Gose, P. 2000. “The State as a Chosen Woman: Brideservice and the Feeding of Tributaries in the Inka Empire.” *American Anthropologist* 102:84-97.

Gose, P. 2006. "Mountains Historicized: Ancestors and Landscape in the Colonial Andes." In (ed.) Dransart, P. *Kay Pacha: cultivating earth and water in the Andes*. BAR International Series 1478:29.

Gould, S.J. 1987. *Time’s Arrow, Time’s Cycle: Myth and Metaphor in the Discovery of Geological Time*. Cambridge, Massachusetts: Harvard University Press.

Graeber, D. 2001. *Toward an Anthropological Theory of Value: The False Coin of our own Dreams*. New York: Palgrave.

Graeber, D. 2006. “Turning Modes of Production Inside Out. Or, Why Capitalism is a Transformation of Slavery.” *Critique of Anthropology* 26(1):61-85.

Graeber, D. 2011. *Debt: The First 5,000 Years*. Brooklyn New York: Melville House.

Guaman Poma de Ayala, F. 1980[1614]. *El primer nueva corónica y bien gobierno*. Vol 1. (eds.) Murra, J. V. Adorno, R. Translation and textual analysis of the Quechua by Jorge I. Urioste. Mexico City: Siglo Veintiuno.

Haberl, H., Erb, K.H., Krausmann, F., Gaube, V., Bondeau, A., Plutzar, C., Gingrich, S., Lucht, W., and Fischer-Kowalski, M. 2007. “Quantifying and mapping the human appropriation of net primary production in earth's terrestrial ecosystems.” *Proceedings of the National Academy of Sciences* 104(31):12942-12947.

Hagstrum, M.B. 1989. *Technological continuity and change: ceramic ethnoarchaeology in the Peruvian Andes*. PhD Thesis. University of California, Los Angeles.

Harris, O. 1986. “From asymmetry to triangle: symbolic transformations in northern Potosí.” In (eds.) Murra, J.V., Wachtel, N., and Revel, J. *Anthropological History of Andean Polities*. Cambridge: Cambridge University Press, pp. 260-279.

Harris, O. 1989. “The Earth and the State: the Sources and Meanings of Money in Northern Potosí, Bolivia” In (eds.) Parry, J., and Bloch, M. *Money and the Morality of Exchange*. Cambridge: Cambridge University Press, pp. 232-268.

Harris, O. 2007. “What makes people work?” In (eds.) Astuti, R., Parry, J., and Stafford, C. *Questions of Anthropology.* Oxford: Berg, pp. 137-165.

Harth-Terré, E. 1965. “Tecnica y Arte de la Cantería Incaica.” *Revista Universitaria* 51-52:152-168.

Hastorf, C.A. 1983. *Prehistoric agricultural intensification and political development in the Jauja region of Central Peru*. Doctoral dissertation. University of California.

Hastorf, C.A. 1990. “The effect of the Inka state on Sausa agricultural production and crop consumption.” *American Antiquity* 262-290.

Hastorf, C.A. 1991. “Gender, space, and food in prehistory.” In (eds.) Gero, J. M., and Conkey, M. W. *Engendering archaeology: women and prehistory*. Wiley-Blackwell, pp. 132-159.

Hastorf, C.A. 1993. *Agriculture and the Onset of Political Inequality before the Inka*. Cambridge: Cambridge University Press.

Hastorf, C., Whitehead, W.T., and Johannessen, S. 2005. “Late Prehistoric Wood Use in an Andean Intermontane Valley.” *Economic Botany* 59(4):337-355.

Hayashida, F.M. 2008. “Ancient beer and modern brewers: Ethnoarchaeological observations of chicha production in two regions of the North Coast of Peru.” *Journal of Anthropological Archaeology* 27:161-174.

Hayashida, F.M., and Guzmán, N. 2015. “Reading the Material Record of Inka Rule.” In (ed.) Shimada, I. *The Inka Empire: A Multidisciplinary Approach*. Austin: University of Texas Press, pp. 287-305.

Hayden, B. 1995. "Pathways to Power." In (eds.) Price, T.D., and Feinman, G.M. *Foundations of Social Inequality*. New York: Plenum Press, pp. 15-86.

Henshilwood, C.S., and Marean, C.W. 2003. “The origin of modern human behavior.” *Current Anthropology* 44(5):627-651.

Herring, A. 2010. “Shimmering foundation: the twelve-angled stone of Inca Cusco.” *Critical Inquiry* 37(1):60-105.

Hornborg, A. 1997. ”Människans försörjning: Teknologi, ekologi och ekonomi i ett globalt och historiskt perspektiv.” *Humanekologiska Essäer* 1. Lund: Human Ecology Division.

Hornborg, A. 1998. “Toward an Ecological Theory of Unequal Exchange: Articulating world system theory and ecological economics.” *Ecological Economics* 25(1):127-136.

Hornborg, A. 2001. *The Power of the Machine: Global Inequalities of Economy, Technology, and Environment*, Lanham, MD.: Altamira /Rowman and Littlefield.

Hornborg, A. 2003. “The Unequal Exchange of Time and Space: Toward a Non-Normative Ecological Theory of Exploitation.” *Journal of Ecological Anthropology* 7:4-10.

Hornborg, A.2006a. “Footprints in the cotton fields: The Industrial Revolution as time-space appropriation and environmental load displacement.” *Ecological Economics* 59(1):74-81.

Hornborg, A. 2006b. “Animism, fetishism, and objectivism as strategies for knowing (or not knowing) the world.” *Ethnos* 71(1):21-32.

Hornborg, A. 2007. “Introduction: Environmental History as Political Ecology.” In (eds.) Hornborg, A., McNeill, J.R., and Martinez-Alier, J. *Rethinking Environmental History: World-System History and Global Environmental Change*. Plymouth: Altamira Press, pp. 1-24.

Hornborg, A. 2014. “Political Economy, Ethnogenesis, and Language Dispersals in the Prehispanic Andes: A World-System Perspective.” *American Anthropologist* 116(4):810-823.

Hornborg, A. 2016. *Global Magic: Technologies of Appropriation from Ancient Rome to Wall Street*. US: Palgrave Macmillan.

Hornborg, A., Eriksen, L., and Bogadóttir, R. 2014. "Correlating Landesque Capital and Ethnopolitical Integration in Pre-Columbian South America." In (eds.) Håkansson, N.T., and Widgren, M. *Landesque Capital: The Historical Ecology of Enduring Landscape Modifications*. Walnut Creek, CA.: Left Coast Press, pp. 215-231.

Hyslop, J. 1984. *The Inka Road System*. New York: Academic Press.

Håkansson, N.T., and Widgren, M. (eds.) 2014. *Landesque Capital: The Historical Ecology of Enduring Landscape Modifications*. Walnut Creek, CA.: Left Coast Press.

INRENA 1996. *Mapa Forestal del Perú*. Instituto Nacional de Recursos Naturales (INRENA), Lima.

Ingold, T. 1995. “Work, Time and Industry.” *Time & Society* 4(1):5-28.

Ingold, T. 2010. “The Textility of Making.” *Cambridge Journal of Economics* 34(1):91-102.

Isbell, B.J. 1985[1978]. *To Defend Ourselves: Ecology and Ritual in an Andean Village*. Prospect Heights: Waveland Press.

Isbell, W.H. 2008a. “Conclusion.” In (eds.) Silverman, H., and Isbell, W.H. *Handbook of South American Archaeology.* Springer: New York.

Isbell, W.H. 2008b. "Wari and Tiwanaku: International Identities in the Central Andean Middle Horizon." In (eds.) Silverman, H., and Isbell, W. H. *Handbook of South American Archaeology*. New York: Springer, pp. 731-759.

Isendahl, C., and Smith, M.E. 2013. "Sustainable agrarian urbanism: The low-density cities of the Mayas and Aztecs." *Cities* 31:132-143.

Jennings, J. 2005. "La Chichera y el Patrón: Chicha and the Energetics of Feasting in the Prehistoric Andes." *Archeological Papers of the American Anthropological Association*, Special Issue: Foundations of Power in the Prehispanic Andes 14:241-259.

Jennings, J. 2014. "A Glass for the Gods and a Gift to My Neighbor." in (eds.) Pierce, G., and Toxqui, Á. *Alcohol in Latin America: A Social and Cultural History.* Tucson: University of Arizona Press, pp. 25-45.

Johannessen, S., and Hastorf, C.A. 1990. "A History of Fuel Management (A.D. 500 to the Present) in the Mantaro Valley, Peru." *Journal of Ethnobiology* 10(1):61-90.

Julien, C.J. 1985. "Guano and resource control in sixteenth-century Arequipa." In (eds.) Masuda, S., Shimada, I., and Morris, C. *Andean Ecology and Civilization.* University of Tokyo, pp. 185-231.

Julien, C.J. 1988. "How Inca Decimal Administration Worked." *Ethnohistory* 35(3):257-279.

Julien, C.J. 1993. "Finding a Fit: Archaeology and Ethnohistory of the Inkas." In (ed.) Malpass, M. *Provincial Inka: Archaeological and Ethnohistorical Assessments of the Impact of the Inka State*. Iowa City: University of Iowa Press, pp. 177-233.

Julien, C.J. 2000. *Reading Inca History*. Iowa City: University of Iowa Press.

Julien, C.J. 2009. "The Embryonic Inca Empire, with Particular Reference to Chinchaysuyo." In (eds.) Dehlinger, J., and Dehlinger, H. *Architecture – Design Methods – Inca Structures. Festschrift for Jean-Pierre Protzen*. Kassel: Kassel University Press, pp. 104-113.

Katterman, G., and Riddell, F. 1994. "Cache of Inca Textiles from Rodadero, Acarí Valley, Peru." *Andean Past* 4:141-67.

Kaulicke, P. 2001. *Memoria y Muerte en el Perú Antiguo*. Pontificia Universidad Católica del Perú, Lima.

Keith, R.G. 1976. *Conquest and Agrarian Change: The Emergence of the Hacienda System on the Peruvian Coast.* Cambridge: Harvard University Press.

Kendall, A. 1978[1973]. *Everyday Life of the Incas*. First paperback edition. London: B.T. Batsford Ltd.

Kendall, A. 1985. "Aspects of Inca Architecture: Description, function and chronology." BAR International Series 242. Oxford.

Kesseli, R., and Pärssinen, M. 2005. ”Identidad Étnica y Muerte: Torres Funerarias (chullpas) como Símbolos de Poder Étnico en el Altiplano Boliviano de Pakasa (1250-1600 d. C.).” *Bulletin de L'Institut Francais d'Études Andine*s 34(3):379-410.

Kolata, A.L. 2013. *Ancient Inca*. Cambridge, New York: Cambridge University Press.

Kolata, A.L., and Sangines, C.P. 1992. “Tiwanaku: The City at the Center.” In (ed.) Townsend, R.F. *The Ancient Americas: Art From Sacred Landscapes.* The Art Institute of Chicago, pp. 317-333.

Kopytoff, I. 1986. “The Cultural biography of Things: Commoditization as Process.” In (ed.) Appadurai, A. *The social life of things: Commodities in cultural Perspective*. Cambridge: Cambridge University Press, pp. 64-94.

Kosiba, S. 2012. “Emplacing Value, Cultivating Order.” In (eds.) Papadopoulos, J.K., and Urton, G. *The Construction of Value in the Ancient World*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 97-127.

Kosok, P. 1965. *Life, Land, and Water in Ancient Peru*. New York: Long Island University Press.

Krögel, A. 2015. “Food Production, Consumption, and Identity Politics in Tahuantinsuyu and Colonial Perú.” In (ed.) Helstosky, C. *The Routledge History of Food*. New York: Routledge, pp. 19-41.

Kuznar, L.A. 1991a. “Mathematical Models of Pastoral Production and Herd Composition in Traditional Andean Herds.” *Journal of Quantitative Anthropology* 3:1-17.

Kuznar, L.A. 1991b. ”Herd Composition in an Aymara Community of the Peruvian Altiplano: A Linear Programming Problem.” *Human Ecology* 19(3):369-387.

Kuznar, L.A. 1996. “Periphery/Core Relations in the Inca Empire. Carrots and Sticks in an Andean World System.*” Journal of World-Systems Research* 2(1):1-28.

La Lone, M.B., and La Lone, D.E. 1987. “The Inka State in the Southern Highlands: State Administrative and Production Enclaves.” *Ethnohistory* 34(1):47-62.

Lane, K. 2006. “Through the looking glass: re-assessing the role of agro-pastoralism in the north-central Andean highlands.” *World Archaeology* 38(3):493-510.

Lanning, E.P. 1967. *Peru before the Incas*. Englewood Cliffs: Prentice Hall.

Lau, G.F. 2002. “Feasting and Ancestor Veneration at Chinchawas, North Highlands of Ancash, Peru.” *Latin American Antiquity* 13(3):278-304.

Lau, G.F. 2008. “Ancestor Images in the Andes.” In (eds.) Silverman, H., and Isbell, W.H. *Handbook of South American Archaeology.* Springer: New York, pp. 1027-1045.

Lau, G.F. 2010. “The Work of Surfaces: Object worlds and techniques of enhancement in the Ancient Andes.” *Journal of Material Culture* 15 (3)259-286.

Lee, V. 1990. “The building of Sacsayhuaman.” *Ñawpa Pacha* 24:49-60.

LeVine, T. 1992. *Inka storage systems*. Norman: University of Oklahoma Press.

LeVine, T. 1987. “Inka Labor Service at the Regional Level: The Functional Reality.” *Ethnohistory* 34(1):14-46.

Lumbreras, L.G. 1974. *The Peoples and Cultures of Ancient Peru*. Washington, D.C.: Smithsonian Institution Press.

Lumbreras, L.G. 2006. “Un Formativo sin Cerámica y Cerámica Performativa.” *Estudios Atacameños. Arquelogía y Antropología Surandinas* 32:1-34.

Lumbreras, L.G. 2008. “Los Orígenes de la Sociedad Andina.” In (eds.) Lumbreras, L.G., Kaulicke, P., Santillana, J.I., and Espinoza, W. *Economía Prehispanica*. Lima: Instituto de Estudios Peruanos, pp. 23-136.

MacCormack, S. 1991. *Religion in the Andes: Vision and Imagination in Early Colonial Peru*. Princeton, New Jersey: Princeton University Press.

Maldonado Fonkén, M.S. 2014. “An Introduction to the Bofedales of the Peruvian High Andes.” *Mires and Peat*. International Mire Conservation Group and International Peat Society 15:1-13.

Malpass, M.A. 1996. *Daily Life in the Inca Empire*. Second Edition. Westport, Connecticut: Greenwood Press.

Mannheim, B. 1991. *The Language of the Inka since the European Invasion*. Austin: University of Texas Press.

Marcus, G.E., and Fischer, M.M.J. 1999[1986]. *Anthropology and Cultural Critique: An Experimental Moment in the Human Sciences.* Second Edition. Chicago: The University of Chicago Press.

Marmontel, J.F. 1777. *Les Inkas ou la destruction de l’empire du Pérou*. Vol. 1. Broenner.

Marx, K. 1973[1857]. *Grundrisse: Foundations of the Critique of Political Economy (Rough draft).* Translated by Martin Nicolaus. Source: Grundrisse, Penguin Books in association with New Left Review. Available online at: https://www.marxists.org/archive/marx/works/1857/grundrisse/index.htm

Marx, K. 1970[1875]. *Critique of the Gotha Programme*. Source: Marx/Engels Selected Works, Volume Three, pp. 13-30. Moscow: Progress Publishers. Available online at: https://www.marxists.org/archive/marx/works/1875/gotha/ch01.htm

Martinez-Alier, J. 2007. “Marxism, Social Metabolism, and International Trade.” In (eds.) Hornborg, A., McNeill, J. R., and Martinez-Alier, J. *Rethinking*

Environmental History: World-System History and Global Environmental Change. Rowman Altamira, pp. 221-237.

Masson, L. 1987. “Rehabilitación de Andenes en la Comunidad de San Perdro de Casta, Lima.” In (eds.) Torre, C., and Burga, M. *Andenes y Camellones en el Peru Andino: Historia, Presente y Futuro*. 2. Ed. Lima: Consejo nacional de ciencia y technología Concytec, pp. 207-216

Matos Mendieta, R. 1994. *Pumpu: Centro Administrativo Inka de la Puna de Junín*. Lima: Editorial Horizonte.

Mauss, M. 1990[1925]. *The Gift: the Form and Reason for Exchange in Archaic Societies.* London: Routledge.

Mayer, E. 2002. *The Articulated Peasant: Household Economies in the Andes*. Boulder, Colorado: Westview.

Mayer, E., and Fonseca, C. 1979. *Sistemas Agrarios en la Cuenca del Río Cañete*. Lima: Oficina Nacional de Evaluación de Recursos Naurales (ONERN).

McEwan, G. F. 2006. *The Incas: New Perspectives*. New York: W. W. Norton and Company.

Mellor, M. 1997. “Women, Nature and the Social Construction of Economic Man.” *Ecological Economics* 20:129-140.

Menotti, F. 1998. *The Inkas: Last Stage of Stone Masonry Development in the Andes*. BAR International Series 735. Oxford: Archaeopress.

MINAM 2010. *Mapa de Pastos Altoandinos*. Ministerio del Ambiente (MINAM), Peru.

MINAM 2012. *Memoría Descriptiva del Mapa de Cobertura Vegetal del Peru*. Ministerio del Ambiente (MINAM) Lima, Peru.

Minkowski, H. 1923. “Space and Time.” In *The Principle of Relativity: A Collection of Original Memoirs on the Special and General Theory of Relativity*, Dover Publications Inc.

Miracle, A.W., and Yapita Moya, J.D. 1981. “Time and Space in Aymara” In (ed.) Hardman, M.J. *The Aymara Language in Its Social and Cultural Context*. Gainesville: University Presses of Florida.

Moore, J.D. 1989. “Pre-Hispanic Beer in Coastal Peru: Technology and Social Context of Prehistoric Production.” *American Anthropologist* New Series 91(3):682-695.

Moore, J.D. 1992. “Pattern and meaning in prehistoric Peruvian architecture: The architecture of social control in the Chimu state.” *Latin American Antiquity* 3(2):95-113.

Moore, J.D. 1996. “The Archaeology of Plazas and the Proxemics of Ritual.” *American Anthropologist* 98:789-802.

Moore, J.D. 2005. *Cultural Landscapes in the Ancient Andes: Archaeologies of Place*. Gainesville, Florida: University Press of Florida.

Moore, J.D., and Mackey, C.J. 2008. “The Chimú Empire.” In (eds.) Silverman, H., and Isbell, W. H. *Handbook of South American Archaeology*. New York: Springer, pp.783-807.

Moorehead, E.L. 1978. “Highland Inca Architecture in Adobe.” *Ñawpa Pacha* 16(1):65-94.

Morris, A. 1999. “The Agricultural Base of the Pre-Incan Andean Civilizations.” *The Geographical Journal* 165(3):286-295.

Morris, C. 1979. “Maize Beer in the Economics, Politics, and Religion of the Inca Empire.” In (eds.) Gastineau, C.F., Darby, W.J., and Turner, T.B. *Fermented Food Beverages in Nutrition*. New York: Academic.

Morris, C. 1982. “The infrastructure of Inka control in the Peruvian central highlands.” In (eds.) Collier, G.A., Rosaldo, R.I., and Wirth, J.D. *The Inca and Aztec States 1400-1800*. New York and London: Academic Press, pp. 237-262.

Morris, C. 1986. “Storage, supply, and redistribution in the economy of the Inka state.” In (eds.) Murra, J.V., Wachtel, N., and Revel, J. *Anthropological History of Andean Polities*. Cambridge: Cambridge University Press, pp. 59-68.

Morris, C. 1993. "The Wealth of a Native American State: Value, Investment, and Mobilization in the Inka Economy." In (eds.) Henderson, J., and Netherly, P. *Configurations of Power: Holistic Anthropology in Theory and Practice.* Cornell University Press, Ithaca, 36-50.

Morris, C. 2004. “Enclosures of Power: The Multiple Spaces of Inca Administrative Palaces.” In (eds.) Evans, S.T., and Pillsbury, J. *Palaces of the Ancient New World*. Washington, D.C.: Dumbarton Oaks, pp. 299-324.

Morris, C., and Thompson, D. E. 1985. *Huánuco Pampa: an Inca City and its Hinterland*. Thames and Hudson.

Moseley, M. 1992. *The Incas and Their Ancestors*. New York: Thames and Hudson.

Muelle, J.C. 1978. “Technología del Barro en el Peru Precolumbino.” In (ed.) Ravines, R. *Technología Andina*. Lima, Peru: Instituto de Estudios Peruanos, pp. 573-579.

Munn, N.D. 1992. “The Cultural Anthropology of Time: A Critical Essay.” *Annual Review of Anthropology* 21:93-123.

Murra, J.V. 1960. "Rite and crop in the Inca state." In (ed.) Diamond, S. *Culture in History: Essays in Honor of Paul Radin.* New York: Columbia University Press, pp. 393-407.

Murra, J. V. 1962. “Cloth and its functions in the Inca State.” *American Anthropologist* 64(4):710-728.

Murra, J.V. 1965. "Herds and Herders in the Inca State." In (eds.) Leeds, A., and Vayda, A.P. *Man, Culture and Animals: The Role of Animals in Human Ecological Adjustments*. Washington: American Association for the Advancement of Science, pp. 185-215.

Murra, J.V. 1970. "Current Research and Prospects in Andean Ethnohistory." *Latin American Research Review* 5:3-36.

Murra, J.V. 1972. "El "control vertical" de un máximo de pisos ecológicos en la economía de las sociedades andinas." Huanuco, Peru: Universidad Hemilo Valdizán, pp. 427-476.

Murra, J. V. 1980. *The Economic Organization of the Inka State*. Greenwich, Connecticut: Jai Press Inc.

Murra, J.V. 1982. "The *Mit'a* Obligations of Ethnic Groups to the Inka State." In (eds.) Collier, G.A., Rosaldo, R.I., and Wirth, J.D. *The Inca and Aztec States 1400-1800*. New York and London: Academic Press, pp. 237-262.

Murra, J.V. 1985. "The limits and limitations of the "vertical archipelago" in the Andes." *Andean ecology and civilization: An interdisciplinary perspective on Andean ecological complementarity*. Tokyo: University of Tokyo Press, pp. 15-20.

Nair, S.E. 2009. "Inca Architecture and the Conquest of the Countryside." In (eds.) Dehlinger, J., and Dehlinger, H. *Architecture – Design Methods – Inca Structures. Festschrift for Jean-Pierre Protzen.* Kassel: Kassel University Press, pp. 114-125.

Nair, S.E. 2015. *At Home with the Sapa Inca: Architecture, Space, and Legacy at Chinchero*. Austin: University of Texas Press.

Nair, S.E., and Protzen, J-P. 2015. "The Inka Built Environment." In (ed.) Shimada, I. *The Inka Empire: A Multidisciplinary Approach*. Austin: University of Texas Press, pp. 215-232.

Netherly, P.J. 1977. *Local level lords on the North Coast of Peru*. Cornell University.

Nicholson, E.G. 1960. "Chicha maize types and chicha manufacture in Peru." *Economic Botany* 14(4):290-299.

Niles, S.A. 1982. "Style and Function in Inca Agricultural Works near Cuzco." *Ñawpa Pacha* 20(1):163-182.

Niles, S.A. 1987. "Niched Walls in Inca Design." *Journal of the Society of Architectural Historians* 46(3):277-285.

Niles, S.A. 1999. *The Shape of Inca History: Narrative and Architecture in an Andean Empire.* Iowa City, IA, USA: University of Iowa Press.

Niles, S.A. 2015. "Considering Inka Royal Estates." In (ed.) Shimada, I. *The Inka Empire: A Multidisciplinary Approach*. Austin: University of Texas Press, pp. 233-246.

Novoa, C., and Wheeler, J. C. 1984. “Llama and Alpaca.” In (ed.) Mason, I. *Evolution of Domesticated Animals*. London: Longman.

Ogburn, D. 2004a. “Evidence for Long-Distance Tansportation of Building Stones in the Inka Empire, from Cuzco, Peru, to Saraguro, Ecuador.” *Latin American Antiquity* 15(4):419-439.

Ogburn, D. 2004b. “Power in the Stone: The Long-Distance Movement of Building Blocks in the Inka Empire.” *Ethnohistory* 51:101-135.

Outwater, J.O. Jr. 1978. “Edificación de la Fortaleza de Ollantaytambo.” In (ed.) Ravines, R. *Technología Andina*. Lima, Peru: Instituto de Estudios Peruanos, pp. 580-589.

Palacios Ríos, F. 1977. “Pastizales de Regadío para Alpacas.” In (ed.) Flores Ochoa, J.A. *Pastores de Puna Uywamichiq Punarunakuna*. Lima, Peru: Instituto de Estudios Peruanos.

Pasiecznik, N. M., Felker, P., Harris, P.J.C., Harsh, L.N., Cruz, G., Tewari, J.C., Cadoret, K., and Maldonado, L.J. 2001. *The* Prosopis juliflora – Prosopis pallida *Complex: A Monograph* HDRA, Coventry, UK.

Paulson, S. 2005. “Gendered Practices and Landscapes in the Andes: The Shape of Asymmetrical Exchanges.” In (eds.) Paulson, S., and Gezon, L.L. *Political Ecology across Spaces, Scales and Social Groups*. New Brunswick: Rutgers University Press, pp. 174-195.

Perlov, D.C. 1979. *Womens Work, Power, and Access to Educational Mobility: An Investigation of the Beermakers of Highland Bolivia.* Masters thesis. University of California.

Phipps, E. 2004a. “Garments and Identity in the Colonial Andes.” In (eds.) Phipps, E., Hecht, J., and Martín, C.E. *The Colonial Andes. Tapestries and Silverwork, 1530-1830*. New Haven and London: Yale University Press, pp. 16-39.

Phipps, E. 2004b. “Cumbi to Tapestry: Collection, Innovation, and Transformation of the Colonial Andean Tapestry Tradition.” In (eds.) Phipps, E., Hecht, J., and Martín, C.E. *The Colonial Andes. Tapestries and Silverwork, 1530-1830*. New Haven and London: Yale University Press, pp. 72-99.

Phipps, E. 2015. “Inka Textile Traditions and Their Colonial Counterparts.” In (ed.) Shimada, I. *The Inka Empire: A Multidisciplinary Approach*. Austin: University of Texas Press, pp. 197-214.

Piketty, T. 2014. *Capital in the Twenty-First Century.* Translated by Arhur Goldhammer. Cambridge, Massachusetts: The Belknap Press of Harvard University Press.

Pillsbury, J. (ed.) 2008. *Guide to documentary sources for Andean Studies 1530-1900*. 3 vols. Norman: University of Oklahoma Press.

Platt, T. 1986 “Mirrors and maize: the concept of yanantin among the Macha of Bolivia.” In (eds.) Murra, J.V., Wachtel, N., and Revel, J. *Anthropological*

History of Andean Polities. Cambridge: Cambridge University Press, pp. 228-259.

Polanyi, K. 1944. *The Great Transformation: The Political and Economic Origins of Our Time*. Boston: Beacon Press.

Polanyi, K. 1957. "The economy as instituted process." In (eds.) Polanyi, K., Arensberg, C.M., and Pearson, H.W. *Trade and Market in the Early Empires: Economies in History and Theory*. New York: Free Press, pp. 243-270.

Pozo, J.Y. 2002. *Yanantin: La filosofía dialógica intercultural del Manuscrito de Huarochiri*. Quito, Ecuador: Abya-Yala.

Prescott, W. 1847. *History of the Conquest of Peru*. London: Bentley.

Price, T.D., and Feinman, G.M. 2010. "Social Inequality and the Evolution of Human Social Organization." In (eds.) Price, T.D., and Feinman, G.M. *Pathways to Power: New Perspectives on the Emergence of Social Inequality*. Springer Science, pp. 1-14.

Prieto, G.O. 2011. "Chicha Production during the Chimú Period at San José de Moro, Jequetepeque Valley, North Coast of Peru." In (eds.) Zori, C.M., and Johnson, I. *From state to Empire in the Prehistoric Jequetepeque Valley*. BAR International Series 2310. Oxford: Archaeopress.

Prigogine, I. 1997. *The End of Certainty: Time, Chaos, and the New Laws of Nature*. In collaboration with Isabelle Stengers. New York: The Free Press.

Protzen, J-P. 1983. "Inca Quarrying and Stonecutting." *Ñawpa Pacha* 21(1):183-214.

Protzen, J-P. 1985. "Inca quarrying and stonecutting." *Journal of the Society of Architectural Historians* 44(2):161-182.

Protzen, J-P. 1986. "Inca Stonemasonry." *Scientific American* 254(2):80-88.

Protzen, J-P. 1987 (revised 1991). "The Fortress of Saqsa Waman: Was it Ever Finished?" *Ñawpa Pacha* 25/27:155-175.

Protzen, J-P. 1993. *Inca Architecture and Construction at Ollantaytambo*. New York: Oxford University Press.

Protzen, J-P. 2000. "Inca Architecture." In (ed.) Minelli, L.L. *The Inca World: The Development of Pre-Columbian Peru, A.D. 1000 – 1534*. University of Oklahoma Press, Norman.

Protzen, J-P., and Nair, S. 1997. "Who Taught the Inca Stone Masons their Skills? A Comparison of Tiahuanaco and Inca Cut-Stone Masonry." *Journal of the Society of Architectural Historians* 56(2):146-167.

Proulx, D.A. 2008. "Paracas and Nasca: Regional Cultures on the South Coast of Peru." In (eds.) Silverman, H., and Isbell, W. H. *Handbook of South American Archaeology*. New York: Springer, pp. 563-585.

Pärssinen, M. 2015. “Collasuyu of the Inka State.” In (ed.) Shimada, I. *The Inka Empire: A Multidisciplinary Approach*. Austin: University of Texas Press, pp. 265-285.

Quilter, J. 1990. “The Moche Revolt of the Objects.” *Latin American Antiquity* 1(1):42-65.

Quispe, E. C., Rodríguez, T. C., Iñiguez, L.R., and Mueller, J.P. 2009. “Producción de Fibra de Alpaca, Llama, Vicuña y Guanaco en Sudamérica.” *Animal Genetic Resources Information* 45:1-14.

Ramírez, S.E. 2005. *To Feed and Be Fed: The Cosmological Bases of Authority and Identity in the Andes*. Stanford, California: Stanford University Press.

Ramos Vera, C. 1987. “Reconstrucción, Refacción y Manejo de Andenes en Asillo.” In (eds.) Torre, C., and Burga, M. *Andenes y Camellones en el Peru Andino: Historia, Presente y Futuro*. 2. Ed. Lima: Consejo nacional de ciencia y technología Concytec, pp. 225-239.

Ravines, R. 1978 “Edificación y vivienda.” In (ed.) Ravines, R. *Technología Andina*. Lima, Peru: Instituto de Estudios Peruanos, pp. 557-571.

Reinhard, J., and Ceruti, M.C. 2000. *Investigaciones arqueológicas en el volcán Llullaillaco: Complejo cermonial incaica de alta montaña*. Salta: Universidad Católico de Salta.

Reinhard, J., and Ceruti, M.C. 2010. *Inca Rituals and Sacred Mountains: A Study of the World’s Highest Archaeological Sites.* Los Angeles: Cotsen Institute of Archaeology, University of California.

Reinhardt, N. 1988. *Our Daily Bread: The Peasant Question and Family Farming in the Colombian Andes*. Berkely and London: University of California Press.

Rodman, A.O., and Cassman, V. 1995. “Andean Tapestry: Structure Informs the Surface.” *Art Journal* 54(2):33-39.

Rostworowski de Diez Canseco, M. 1977. “Reflexiones sobre la reciprocidad Andina.” *Revista del Museo Nacional* 42:341-354.

Rostworowski de Diez Canseco, M. 1999. *History of the Inca Realm*. Translated by Harry B. Iceland, Cambridge, UK: Cambridge University Press.

Rostworowski de Diez Canseco, M. 2000. “The Incas.” In (ed.) Minelli, L.L. *The Inca World: The Development of Pre-Columbian Peru, A.D. 1000-1534.* University of Oklahoma Press: Norman, pp. 143-188.

Rowe, A.P. 1978. “Technical Features of Inca Tapestry Tunics.” *Textile Museum Journal* 17:5-28.

Rowe, A.P. 1980. “Textiles from the burial platform of Las Avispas at Chan Chan.” *Ñawpa Pacha* 18(1)81-148.

Rowe, A.P. 1992. “Provincial Inca Tunics of the South Coast of Peru.” *Textile Museum Journal* 31:5-52.

Rowe, A.P. 1997. "Inca Weaving and Costume." *Textile Museum Journal* 34-35:4-53.

Rowe, J.H. 1944. *An introduction to the archaeology of Cuzco*. No. 2. The Museum.

Rowe, J.H. 1946. "Inca Culture at the Time of the Spanish Conquest." In (ed.) Steward, J.H. *Handbook of South American Indians, Volume 2: The Andean Civilizations*, Smithsonian Institution, Bureau of American Ethnology, Ethnology Bulletin 143. Washington: U.S. Government Printing Office, pp. 183-330.

Rowe, J.H. 1979. "Standardization in Inca Tapestry Tunics." In (eds.) Rowe, A.P., Benson, E.P., and Schaffer, A-L. *The Junius B. Bird Pre-Columbian Textile Conference*, Dumbarton Oaks Research Library and Collection, pp. 239-264.

Sahlins, M. 2007[1972]. *Stone Age Economics*. London: Routledge.

Saignes, T. 1987. "De la borrachera al retrato: Los caciques andinos entre los legitimidades (Charcas)." *Revista Andina* 5(1):139-170.

Salazar, L.C., and Roussakis, V. 2000. "Tejidos y Tejidores del Tahuantinsuyo." In *Los Incas: Arte y símbolos*. Lima: Banco de Crédito, pp. 269-303.

Salazar, L.C., and Burger, R. 2004. "Lifestyles of the Rich and Famous: Luxury and Daily Life in the Households of Machu Picchu's Elite." In (eds.) Evans, S.T., and Pillsbury, J. *Palaces of the Ancient New World*. Washington, D.C.: Dumbarton Oaks Research Library and Collection, pp. 325-358.

Sallnow, M. 1987. *Pilgrims of the Andes: Regional Cults in Cusco*. Washington D.C.: Smithsonian Institution Press.

Salomon, F. 1986. *Native Lords of Quito in the Age of the Incas: The Political Economy of North Andean Chiefdoms*. Cambridge: Cambridge University Press.

Salomon, F. 2004. *The Cord Keepers: Khipus and Cultural Life in a Peruvian Village*. Durham: Duke University Press.

Salomon, F. 2015. "Inkas through Text." In (ed.) Shimada, I. *The Inka Empire: A Multidisciplinary Approach*. Austin: University of Texas Press, pp. 23-38.

Salomon, F., and Urioste, G.L. 1991. *The Huarochirí Manuscript*. Austin: University of Texas Press.

Santillana, J.I. 2008. "Economía Prehispánica en el area Andina (Período Intermedio Temprano, Horizonte Medio y Período Intermedio Tardio)." In (eds.) Lumbreras, L.G., Kaulicke, P., Santillana, J.I., and Espinoza, W. *Economía Prehispanica*. Lima: Instituto de Estudios Peruanos, pp. 231-314.

Schaedel, R. 1988. "Andean World View: Hierarchy or reciprocity, regulation or control?" *Current Anthropology* 29(5):768-75.

Schreiber, K.J. 1987. “Conquest and consolidation: a comparison of the Wari and Inka occupations of a highland Peruvian valley.” *American Antiquity* 52(2):266-284.

Schreiber, K.J. 1992. *Wari Imperialism in Middle Horizon Peru*. Anthropological Papers, No. 87. Ann Arbor: University of Michigan.

Shady Solís, R. 2006. “America’s First City? The case of Late Archaic Caral.” In (eds.) Isbell, W.H., and Silverman, H. *Andean Archaeology III.* New York: Springer, pp. 28-66.

Sherbondy, J.E. 1987 “The Incaic Organization of Terraced Irrigation in Cuzco, Peru.” In (eds.) Denevan, W.M., Mathewson, K., and Knapp, G. *Proceedings Pre-Hispanic Agricultural Fields in the Andean Region.* Oxford: BAR International Series 359:365-371.

Shimada, M., and Shimada, I. 1985. “Prehistoric Llama Breeding and Herding on the North Coast of Peru.” *American Antiquity* 50(1):3-26.

Shimada, M., and Shimada, I. 1987. “Comment on the Function and Husbandry of Alpaca.” *American Antiquity* 52(4):836-839.

Shimada, I. 1994. *Pampa Grande and the Moche Culture*. Austin: University of Texas Press.

Shimada, I. 2015. “Introduction.” In (ed.) Shimada, I. *The Inka Empire: A Multidisciplinary Approach*. Austin: University of Texas Press, pp. 1-19.

Sillar, B. 2000a. *Shaping Culture: Making Pots and Constructing Households. An Ethnoarchaeological Study of Pottery Production, Trade, and Use in the Andes*. BAR International Series 883. Oxford: Archaeopress.

Sillar, B. 2000b. “Dung by Preference: The choice of fuel as an example of how Andean pottery production is embedded within wider technical, social, and economic practices.” *Archaeometry* 42(1):43-60.

Sillar, B. 2009. ”The Social Agency of Things? Animism and Materiality in the Andes.” *Cambridge Archaeological Journal* 19:367-377.

Sillar, B. 2013. “The building and rebuilding of walls: Aspirations, commitments and tensions within an Andean community and the archaeological monument they inhabit.” *Journal of Material Culture* 18(1):27-51.

Silverblatt, I.M. 1978. “Women in the Inca Empire.” *Feminist Studies* 4(3):36-61.

Silverblatt, I.M. 1987. *Moon, Sun, and Witches: Gender Ideologies and Class in Inca and Colonial Peru*. Princeton: Princeton University Press.

Sinha, C., Da Silva Sinha, V., Zinken, J., and Sampaio, W. 2011. “When time is not space: the social and linguistic construction of time intervals and temporal event relations in an Amazonian culture.” *Language and Cognition* 3(1):137-169.

Skar, S.L. 1993[1981]. "Andean Women and the Concept of Space/Time." In Ardener, S. *Women and Space: Ground Rules and Social Maps*. Revised Edition. Oxford, UK: Berg.

Smil, V. 1994. *Energy in World History*. Boulder, Colorado: Westview Press.

Sorokin, P.A., and Merton, R.K. 1937. "Social Time: A Methodological and Functional Analysis." *American Journal of Sociology* 42(6):615-629.

Spurling, G. 1992. *The organization of craft production in the Inka state: the potters and weavers of Milliraya*. Doctoral dissertation. Cornell University.

Stahl, P. W. 2008. "Animal Domestication in South America." In (eds.) Silverman, H. *Handbook of South American Archaeology*. New York: Springer, pp. 121-130.

Staller, J.E. 2008. "Dimensions of Place: The Significance of Centers to the Development of Andean Civilization: An Exploration of the Ushnu Concept." In (ed.) Staller, J.E. *Pre-Columbian Landscapes of Creation and Origin.* New York: Springer, pp. 269-314.

Staller, J.E., and Stross, B. 2013. *Lightning in the Andes and Mesoamerica: Pre-Columbian, Colonial, and Contemporary Perspectives*. Oxford: Oxford University Press.

Stanish, C. 1992. *Andean Political Economy.* Austin: University of Texas Press.

Stanish, C. 1994. "The Hydraulic Hypothesis Revisited: Lake Titicaca Basin Related Fields in Theoretical Perspective." *Latin American Antiquity* 5(4):312-332.

Stanish, C. 2003. *Ancient Titicaca: the evolution of complex society in southern Peru and northern Bolivia*. University of California Press.

Stanish, C. 2010. "Measuring time, Sacred Space and Social Place in the Inca Empire." In (eds.) Morley, I., and Renfrew, C. *The Archaeology of Measurement: Comprehending Heaven Earth and Time in Ancient Societies*. Cambridge: Cambridge University Press, pp. 216-228.

Stanish, C. 2012. "The Revaluation of Landscapes in the Inca Empire as Peircean Replication." In (eds.) Papadopoulos, J.K., and Urton, G. *The Construction of Value in the Ancient World*. Los Angeles: Cotsen Institute of Archaeology Press, pp. 128-136.

Steiner, D. 1993. "Human Ecology as Transdisciplinary Science and Sciences as Part of Human Ecology." In (eds.) Steiner, D., and Nauser, M. *Human Ecology: Fragments of Anti-Fragmentary Views of the World*. London: Routledge, pp. 47-76.

Steward, J.H., and Faron, L.C. 1959. *Native Peoples of South America*. New York: McGraw-Hill.

Swenson, E.R. 2008. "Competitive Feasting, Religious Pluralism and Decentralized Power." In (eds.) Isbell, W.H., and Silverman, H. *Andean Archaeology III*. Springer: New York, pp. 112-142.

Swetnam, T.W., Allen, C.D., and Betancourt, J.L. 1999. "Applied historical ecology: using the past to manage for the future." *Ecological Applications* 9(4):1189-1206.

Taylor, G. 2000. *Camac, Camay y Camasca y Otros Ensayos sobre Huarochirí y Yauyos*. Lima: Institut François, d'Etudes Andines.

Thomas, R.B. 1972. *Human Adaptation to a High Andean Energy Flow System*. Doctoral dissertation. Pennsylvania State University.

Topic, T.L., McGreevy, T. H., and Topic, J.R. 1987. "A Comment on the Breeding and Herding of Llamas and Alpacas on the North Coast of Peru." *American Antiquity* 52(4):832-835.

Torre, C., and Burga, M. (eds.) 1987. *Andenes y Camellones en el Peru Andino: Historia, Presente y Futuro*. 2. Ed. Lima: Consejo nacional de ciencia y technología Concytec.

Treacy, J.M. 1987. "Building and Rebuilding Agricultural terraces in the Colca Valley of Peru." *Yearbook, Conference of Latin Americanist Geographers* 13:51-57.

Treacy, J.M. 1994. *Las Chacras de Coporaque: Andenería y Riego en el Valle del Colca.* Vol. 12. Instituto de Estudios Peruanos.

Trigger, B. 1990. "Monumental Architecture: A Thermodynamic Explanation of Symbolic Behaviour." *World Archaeology* 22(2):119-132.

Tschudi, J.J. 1918. *Contribuciones a la Civilización y Lingüística del Perú Antiguo*. Lima: Imprenta y Librería Sanmartí.

Urton, G. 1997. *The Social Life of Numbers: a Quechua Ontology of Numbers and Philosophy of Aritmetic*. With the collaboration of Primitivo Nina Llanos. Austin: University of Texas Press.

Urton, G. 2008. "The Inca Khipu: Knotted-Cord Record Keeping in the Andes." In (eds.) Silverman, H., and Isbell, W.H. *Handbook of South American Archaeology*. New York: Springer, pp. 831-843.

Urton, G. 2010. "Recording Measure(ments) in the Inka Khipu." In (eds.) Morley, I., and Renfrew, C. *The Archaeology of Measurement: Comprehending Heaven Earth and Time in Ancient Societies*. Cambridge: Cambridge University Press, pp. 54-68.

Urton, G. 2015. "The State of Strings: *Khipu* Administration in the Inka Empire." In (ed.) Shimada, I. *The Inka Empire: A Multidisciplinary Approach*. Austin: University of Texas Press, pp. 149-164.

Valdez, L. M. 1994. "Cahuachi: new evidence for an early Nasca ceremonial role." *Current Anthropology* 35(5):675.

Valdez, L. M. 2006. "Maize Production in Middle Horizon Peru." *Journal of Anthropological Research* 62(1):53-80.

Van de Guchte, M. 1999. "The Inca Cognition of Landscape: Archaeology, Ethnohistory, and the Aesthetic of Alterity." In (eds.) Ashmore, W., and Knapp, A.B. *Archaeologies of Landscape: Contemporary Perspectives.* Malden: Blackwell, pp. 149-168.

Vankat, A., Krepl V., and Kára J. 2010. "Animal Dung as a Source of Energy in remote areas of Indian Himalayas." *Agricultura Tropica et Subtropica* 43(2):140-142.

Vitousek, P. M., Ehrlich, P. R., Ehrlich, A. H., and Matson, P. A. 1986. "Human Appropriation of the Products of Photosynthesis." *BioScience* 36(6):363-373.

Viveiros de Castro, E. 1998. "Cosmological deixis and Amerindian Perspectivism." *Journal of the Royal Anthropological Institute* 4(3):469–488.

Wachtel, N. 1977. *The Vision of the Vanquished: The Spanish Conquest through Indian Eyes*. New York: Barnes & Noble.

Wachtel, N. 1981. "Reciprocity and the Inca State: From Karl Polanyi to John V. Murra." *Research in Economic Anthropology* 4:38-50.

Wachtel, N. 1982. "The Mitimas of the Cochabamba Valley." In (eds.) Collier, G.A., Rosaldo, R.I., and Wirth, J.D. *The Inca and Aztec States 1400-1800*. New York and London: Academic Press, pp. 199-235.

Wackernagel, M., and Rees, W. 1996. *Our Ecological Footprint: Reducing Human Impact on the Earth*. Gabriola Island, BC: New Society Publishers.

Wadley, L. 2001. "What is Cultural Modernity? A General View and a South African Perspective from Rose Cottage Cave." *Cambridge Archaeological Journal* 11(2):201-221.

Wallerstein, I. 2011[1974]. *The Modern World-System I: Capitalist Agriculture and the Origins of the European World-Economy in the Sixteenth Century*. With a new Prologue. Berkeley: University of California Press.

Wedin, Å. 1963. *La cronología de la historia incaica*. Madrid: Insula.

Weismantel, M. 1988. *Food, Gender, and Poverty in the Ecuadorian Andes*. Philadelphia: University of Pennsylvania Press.

Weismantel, M. 2009. "Chicha, Performance and Politics." In (eds.) Jennings, J., and Bowser, B. *Drink, Power, and Society in the Andes.* Gainesville: University Press of Florida, pp. 57-277.

Wheeler, J.C., Russel, A.J.F., and Stanley, H.F. 1992. "A Measure of Loss: Prehispanic Llama and Alpaca Breeds." *Archivos de Zootecnia* 41(154):467-475.

Wheeler, J.C., Russel, A.J.F., and Redden, H. 1995. "Llamas and Alpacas: Pre-Conquest Breeds and Post-Conquest Hybrids." *Journal of Archaeological Science* 22(6):833-840.

Widgren, M. 2004. “Can landscapes be read?” In (eds.) Palang, H., Sooväli, H., Antrop, M., and Setten, G. *European rural landscapes: persistence and change in a globalising environment*. Boston: Kluwer Academic Publishers, pp. 455-465.

Widgren, M. 2010. “Reading the Prehistoric landscape.” *Ymer* 130:69-85.

Williams, L.S. 1990. “Agricultural Terrace Evolution in Latin America.” *Yearbook. Conference of Latin American Geographers* 16:82-93.

Wilson, A.S., Taylor, T. Ceruti, M.C., Chavez, J.A., Reinhard, J., Grimes, V., Meier-Augenstein, W., Cartmell, L., Stern, B., Richards, M.P., and Worobey, M. 2007. “Stable isotope and DNA evidence for ritual sequences in Inca child sacrifice.” *Proceedings of the National Academy of Sciences* 104(42):16456-61.

Winterhalder, B., Larsen, R., and Thomas, R.B. 1974. “Dung as an Essential Resource in a Highland Peruvian Community.” *Human Ecology* 2(2):89-104.

Wittfogel, K.A. 1956. *The hydraulic civilizations*. University of Chicago Press.

Wittfogel, K.A. 1957. *Oriental Despotism: a comparative study of total power*. New Haven: Yale University Press.

Wolf, E. 1982. *Europe and the People without History*. Berkeley: University of California Press.

Yaya, I. 2012. *The Two Faces of Inca History: Dualism in the Narratives and Cosmology of Ancient Cuzco*. Leiden and Boston: Brill.

Zárate, A. 1968[1555]. *Historia del Descubrimiento y Conquista del Perú*. Biblioteca Peruana. Primera Serie. Tomo II. Editores Técnicos Asociados, S.A. Lima.

Zimmerer, K.S. 1991. “Labor Shortages and Crop Diversity in the Southern Peruvian Sierra.” *Geographical Review* 81(4):414-432.

Zimmerer, K.S. 1999. “Overlapping patchworks of Mountain Agriculture in Peru and Bolivia: Toward a Regional-Global Landscape Model.” *Human Ecology* 27(1):135-165.

Zuidema, T.R. 1964. *The ceque system of Cuzco: the social organization of the capital of the Inca.* Vol. 50. Leiden: Brill Archive.

Zuidema, T.R. 1982. "The sidereal lunar calendar of the Incas." *Archaeoastronomy in the New World*. Vol. 1. Cambridge: Cambridge University Press.

Zuidema, T.R. 1983. “Hierarchy and Space in Incaic Social Organization.” *Ethnohistory* 30(2):49-75.

Zuidema, T.R. 2009. “Tiwanaku Iconography and the Calendar.” In (ed.) Young-Sánchez, M. *Tiwanaku. Papers from the 2005 Mayer Center Symposium at the Denven Art Museum*. Denver: Denver Art Museum, pp. 83-100.

Ragnheiður Bogadóttir

Time-space Appropriation in the Inka Empire

A Study of Imperial Metabolism

This thesis analyzes some aspects of the appropriation of labor time and natural space in the Inka Empire (ca. AD 1400 – 1532) in order to illuminate the cultural organization of Inka imperial metabolism. Rather than understanding Inka imperialism simply as a political process with socioecological consequences, it is investigated as an ecological process organized through specific cultural categories. The Inka imperial economy is conceptualized in terms of transfers of time and space between different categories of people.

The thesis thus addresses long-standing questions regarding the economic operation of the Inka Empire as well as central issues in general social theory. It demonstrates how imperial power is based on biophysical flows of embodied labor and land, organized by specific cultural permutations of reciprocity and redistribution. The thesis focuses on estimating these flows through analyses of time-space appropriation. This is done by reconstructing, on the basis of archaeological, historical and ethnographic data, the production processes of three emblematic Inka artifacts: textiles, *chicha* (maize beer), and stone walls.

Human Ecology Division
Lund University

ISSN 1403-5022
ISBN 978-91-7623-898-1