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Taro Before Rice Terraces : Implications of Radiocarbon Determinations, Ethnohistoric Reconstructions, and Ethnography in Dating the Ifugao Terraces

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Irrigated Taro (Colocasia esculenta) *in the Indo-Pacific*
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Taro Before Rice Terraces: Implications of Radiocarbon Determinations, Ethnohistoric Reconstructions, and Ethnography in Dating the Ifugao Terraces

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Recent radiocarbon determinations obtained from Ifugao agricultural terraces suggest later development of rice cultivation in the region. This information is combined with ethnohistoric reconstructions, ethnographic information, and landscape analysis to argue that wet-taro cultivation is an earlier adaptive practice and an important component in the development of Ifugao agricultural system. In addition, the landscape context for the shift in agricultural practice is also presented. As part of a larger study, this article summarizes the probable expansion, and intensification of Ifugao agricultural systems.

1. Introduction

The Ifugao rice terraces of northern Philippines have captured the imagination of the world. They are enshrined in UNESCO's World Heritage List and a major tourist destination. In academia, the Ifugao and their landscape offer an opportunity to understand the interrelationship between culture and environment. Indeed, ethnographic and agricultural studies that focus on the magnificent rice terraces and their builders (presumably, the Ifugao) have been forthcoming in the last few decades. Establishing the construction dates of the agricultural features, however, are still intensely debated. On the one hand, the two to three thousand year old suggestion by Beyer (1955) and Barton (1919) dominates the layperson's and mass media's perception of the age of the terraces. On the other hand, a handful of scholars (Keesing 1962; Lambrecht 1967; Dozier 1966; Acabado 2009) propose a more recent development.

The 'long history' model proposed by Beyer (1955) and Barton (1919), which has become a kind of received wisdom that finds its way into textbooks and national histories (e.g., UNESCO 1995; Jocano 2001), is put into question because of Keesing's (1962) and Lambrecht's (1967) ethnohistoric and ethnographic reconstruction as well as recent radiocarbon determinations (Acabado 2009). This revisionist 'short history', however, does not preclude the existence of small-scale agricultural production in Ifugao. In this paper, I argue, based on ethnographic, ethnohistoric, taro and rice production comparisons, and the timing of rice agricultural intensification and expansion, that irrigated taro preceded wet-rice cultivation in Ifugao.

This paper also presents a synthesis of previous archaeological studies and absolute ages (mostly by Robert Maher) in Ifugao. These culled data are then used to develop an intensification and expansion model of Ifugao agricultural systems. More importantly, a taro-first model is proposed for the initial construction of agricultural terraces in the region.

2. The Ifugao and Their Agricultural Terraces

The Ifugao are one of several minority ethnolinguistic groups in the northern Philippines. They are well known throughout the country and the anthropological world because of their extensive rice terraces. At the turn of the 20th century two prominent figures in Philippine anthropology began an intensive investigation of the Ifugao (Barton 1919, 1955; Beyer 1926, 1955). In 1924, Francis Lambrecht focused on documenting traditional Ifugao customs (1929, 1962, and 1967). Although substantial ethnographic materials on the Ifugao have been published, little archaeological research has been conducted.

The first Spanish description of the Ifugao rice terraces comes from an 1801 letter of Fray Juan Molano, OP (Scott 1974: 199). The Spanish already knew the irrigated, stone-walled fields during the first expeditions to Kiangan in the 1750's, but formal description did not come until the successful Spanish occupation of the town in 1793. Europeans, however, did not discover the valley of Banaue, until 1868 (Scott 1974: 238). The sole archaeological project to date is Maher's (1973) effort to estimate the age of the terraces. Although his

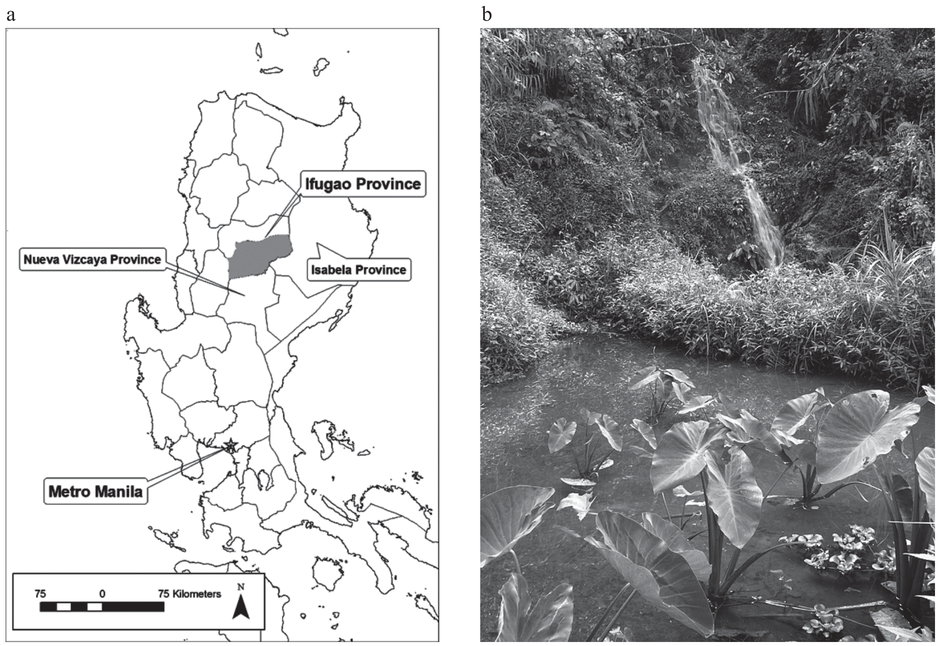

Figure 1 Map of the Philippines with the province of Ifugao shaded. At right: taro (*Colocasia esculenta*) on a terrace, vic. Banaue, Ifugao (photo by P. J. Matthews, 2011)

findings did not date the terraces to a horizon that was previously believed (at least 2000 years old), it provided the only set of radiocarbon dates in Ifugao.

2.1 Dating the Ifugao Rice Terraces

The origins and age of the Ifugao rice terraces in the Philippine Cordillera continue to provoke interest and imagination in academic and popular debates. While one reason can be attributed to the existence of two alternative models of the antiquity of these agricultural marvels—that have significant repercussions for Southeast Asian and Philippine prehistory, another lies in the symbolic importance of the rice terraces in humanity's connection to the landscape. In fact, these monumental structures have become emblematic of the world's cultural landscape heritage (UNESCO 1995).

The debates on the age of Ifugao rice terraces are still intense, even though archaeological and ethnographic studies that try to provide resolution are only a handful. These debates are essentially based on two extreme clusters—pre-Hispanic model (as early as 2000–3000 years BP) and post-contact trend (as late as 300 BP). Ironically, a majority of the population (and scholars) adheres to the former model although it is not based on empirical observations.

These debates remain intense because of the implications that are attached to the antiquity of the terraces. Filipino scholars, specifically archaeologists, tend to adhere to the "earlier" model not because of the evidence provided by Beyer and Barton, but because of nationalistic sentiments. Similarly, most Ifugao that I interacted with prefer the same "earlier" dating. Considering the imposition of national policies after the World War II, especially as these relate to land tenure and access to ancestral domain, a much older date provides validation for their (Ifugao) claim to the land.

2.2 Previous Dates from Ifugao

Radiocarbon and thermoluminescence dates have been proposed for Ifugao terraces and settlements in the 1970s and 1980s (Maher 1973, 1984, 1985; Conklin 1980) (Table 2). A neighboring group who also practice terrace rice farming, the Bontoc, provided a radiocarbon date of 450 years BP (Bodner 1986: 310). These dates, although based on the prevailing technology during that period, failed to establish the timing of colonization and subsequent agricultural expansion in the North-Central Cordillera. Moreover, a detailed analysis and synthesis of the dates provided by Maher has not yet been done.

Recent advances in computer science and the application of Bayesian statistics (Buck *et al.* 1996) in the calibration of absolute dating methods allow us to synthesize Maher's dates and combine them with more recent data. This synthesis will also provide us with the opportunity to correlate colonization, expansion, and intensification with landscape characteristics (through GIS analyses). Furthermore, a growth model that incorporates archaeological chronology, distribution of terraces, and environmental parameters will be developed.

2.3 Maher's Banaue Dates

Maher (1973) excavated four (4) habitation sites in the Municipality of Banaue that produced the first set of radiocarbon dates that purportedly support issues on the antiquity of the terraces.

Table 1 Dates previously obtained from the vicinity of Banaue

Site	Lab ID #	^{14}C Age	Material	Calibrated Dates (CalAD, 2σ—95%)	Descriptions	Obtained by
If1	GX0668	205±100 BP	Charcoal (Runo reed)	A.D. 1470–1879	Sample taken from a pond-field	Maher 1973
If2 55E85	GX1900	325±110 BP	Charcoal (no description given)	A.D. 1401–1808	Sample taken from house platform	Maher 1973
If2 85E90	GX1901	695±100 B.P	Charcoal (no description given)	A.D. 1157–1428	Sample taken from midden on slope	Maher 1973
If2 85E95	GX2184	735±105 B.P	Charcoal (no description given)	A.D. 1039–1406	Sample taken from midden on slope	Maher 1973
If3	GX2138	2950±250 B.P.	Charcoal (no description given)	1409–916 B.C.	Sample was taken from a house platform; no depth or layer description included in published article; early date might not represent terracing.	Maher 1973
Poitan	GX 3138	530±140 BP	No data given	A.D. 1208–1793	From underground chamber (Poitan)	Maher 1975
Poitan	GaK5238	530±100	No data given	A.D. 1274–1631	From underground chamber (Poitan)	Maher 1975
Lugu	UGa-2515	395±60	No data given	A.D. 1430–1639	Terrace embankment post (no taxon)	Conklin 1980: 38

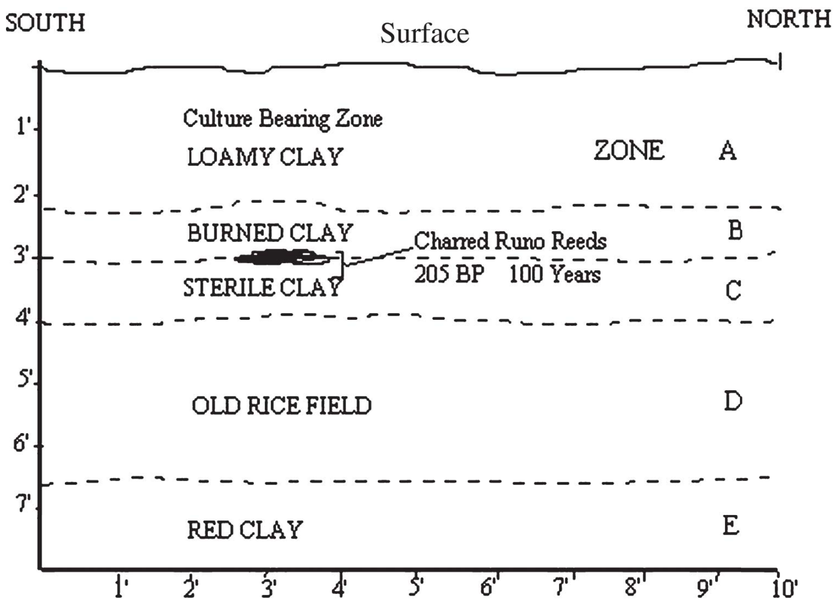

Figure 2 Maher's excavation profile for If1 (1973) (units for both axes = feet)

Site selection in his excavations was guided by information obtained from contemporary Ifugao culture (Maher 1973: 46). Although Maher's main purpose for radiocarbon determinations was to provide dates for the inception of the rice terraces, the contexts of carbon samples used were not made explicit.

Taphonomic processes and agricultural activities in agricultural terraces make samples for radiocarbon determination problematic. Intermixing of materials in cultivated soils is highly possible. This makes it difficult to generate solid evidence for the construction of the rice terraces. Moreover, the earliest dates presented by the radiocarbon determinations were taken from samples not directly associated with rice terraces, but rather from a house platform and a midden. While they may provide evidence for human occupation of the area, they still cast questions to the construction and later expansion of the rice terraces. The only datable sample that relates directly to a rice terrace is from the If1 site, from a layer Maher called Zone B (Fig. 2)—agricultural soil. However, we know that agricultural soils are highly disturbed by plowing. Moreover, water flow might have brought some of the samples he used in that specific layer. Without contextualizing the samples, he dated the layer and not the construction of the terraces.

Maher's radiocarbon estimations gave him sufficient data to contend that the Ifugao rice terraces were pre-Hispanic in origin. However, two issues weakened his estimations: depositional context and in-built age. Almost none of his charcoal samples came directly from rice terraces, and the one that did (If1 in Table 1), is most likely to represent use rather than construction. In-built age is another issue. The 'old wood' problem had not been identified during the period of Maher's study, but we now know that the failure to address this issue can bias '*archaeological chronologies toward an excessive antiquity*' (Schiffer 1986: 19; Taylor 1987). Even an in-built age of a couple of hundred years would make it difficult to test the hypothesis of a Spanish impetus for terrace construction (a calendar date of AD 1401 might actually be Spanish period event).

While Maher's conclusions remain valid, the terraces might have been used initially for taro cultivation (Eggan 1967; Keesing 1962). Galvey reported irrigated fields of root crops in Benguet in 1829 (Keesing 1962: 319–320). It is possible that changes in population composition and density resulted in crop modification—taro to rice.

2.4 Maher's Dates from other Ifugao Localities

Maher (1985, 1989) also excavated lower-elevation sites in Ifugao province, namely, Bintacan Cave and Burnay agricultural district (Boble and Kiyyangan villages) (Tables 2 and 3). These excavations provided thermoluminescence dates that suggest early settlements and movement of people along the Ibulao River. Although caution has to be taken in considering these dates because of the dearth of information on the laboratory that processed samples for TL analysis, these are dates that provide information on early settlers of the province—and eventual development of agricultural terracing technology.

3. Recent Dates from Banaue

One of the goals of my Ifugao research is to validate Maher's dates from the valley of Banaue. I therefore excavated areas adjacent to his original excavation sites. In addition, since Maher's report of the dates he obtained was sketchy, the methodology utilized in this study as well as the radiocarbon dates gathered were combined with Maher's dates to develop a chronology for Banaue.

Table 2 Radiocarbon dates obtained from Burnay district

Site	Lab ID #	^{14}C Age	Material	Calibrated Dates (CalAD, 2σ—95%)
Banghallan 1 (If-20)	GaK-6442	890±310	Charcoal (no description given)	AD 441–AD 1648
Banghallan 2 (If-20)	UGA-1541	1340±375	Charcoal (no description given)	176 BC–AD 1338

Note: excavation at Boble did not provide datable materials.

Table 3 TL dates from Kiyyangan village and Bintacan cave

Site	Level Info	TL Date
Bintacan Cave	Level F	1620 BP Alpha 476
	Level E	1420 BP (±20%) Alpha 480
	Level C	760 BP (±20%) Alpha 479
Kiyyangan Village	No data	820 BP, Alpha 566
		720 BP, Alpha 671

Table 4 Agricultural districts and sites tested during the 2007 field season

District	Sites tested	Context	Dates excavated
Poitan	Gawwa	Village edge and abandoned rice fields	July 2009
Bannawol	Ambalyu	Village	July 2009
	Bocos	Rice terrace and Village	August 2009

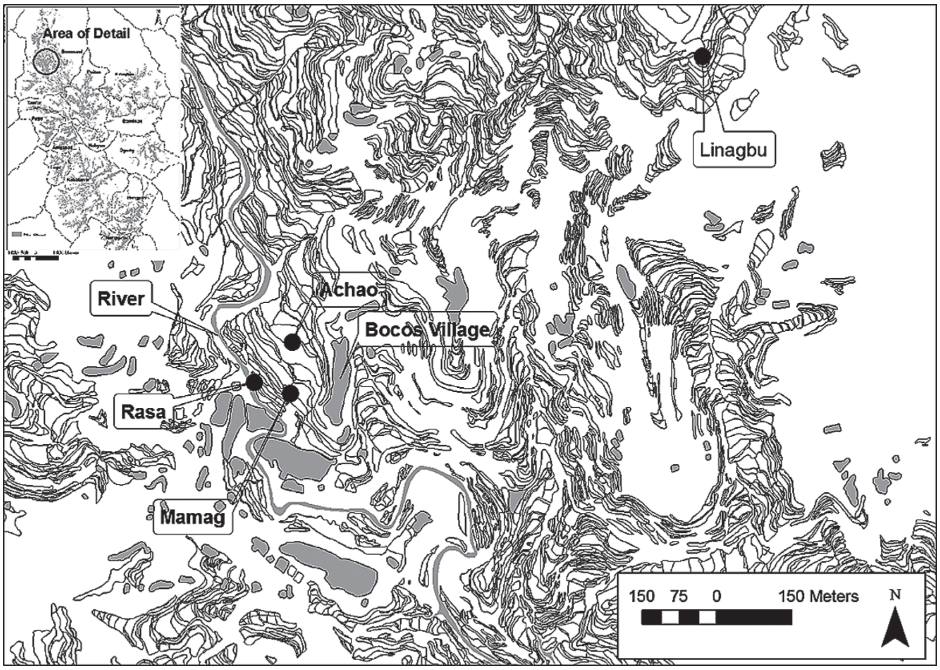

Figure 3 Map showing present-day terraces and sites excavated at Bocos village, Banaue, in 2007

Three localities within the municipality of Banaue were excavated. Two areas are present-day villages (Poitan and Ambalyu) and the majority of the excavated units are from the terraces of Barangay Bocos (Fig. 3). In addition to Maher's ethnographic bases, I utilized GIS landscape analyses to choose fields to excavate, with the primary assumption that the optimal areas for rice production (i.e., gentle slope and proximity to water source) would provide earlier dates.

4. Dating The Ifugao Terraces: Bayesian Approach

Radiocarbon dating provides archaeologists with a powerful means to determine the timing of events in the distant past (for detailed discussion, refer to Taylor 1987; Schiffer 1986). In archaeology, a piece of organic material recovered from a particular context may be associ-

Table 5 Radiocarbon determinations from the 2007 field season

Excavation unit	Lab ID #	Material	Depth	14C age BP	Cal AD (95.4% Probability)
Alang	AA78965	Charcoal: *Pinus kesiya* Royle ex Gordon (PIKE)	60 cm	137±38	1669–1946
Tupla-1	AA78966	Charcoal: PIKE	48 cm	59±37	1689–1926
Tupla-2	AA78967	Wood: PIKE	75 cm	post-bomb±	<1950
Lukahi	AA78968	Charcoal: PIKE	110 cm	post-bomb±	<1950
Linagbu	AA78969	Charcoal: PIKE	125 cm	180±38	1648–1954
Linagbu	AA78970	Charcoal: PIKE	55 cm	131±38	1669–1944
Rasa	AA78971	Wood: PIKE	75 cm	313±38	1473–1650
Rasa	AA78972	Wood: PIKE	35 cm	164±38	1661–1953
Mamag	AA78973	Wood: PIKE	52 cm	119±38	1677–1941
Mamag	AA78974	Wood: PIKE	85 cm	485±39	1326–1469
Achao2	AA78975	Charcoal: PIKE	130 cm	193±35	1645–1955
Poitan-1	AA78976	Animal Bone	75 cm	148±47	1665–1952

ated with an event of interest. This organic sample is sent to a laboratory to measure the ratio of ^{14}C and the stable carbon isotope ^{12}C. The laboratory converts this ratio to a conventional ^{14}C age (Stuiver and Polach 1977) and provides this to the archaeologist along with an estimate of the uncertainty of the measurement. The conventional ^{14}C age is then calibrated by the archaeologist to gain an estimate of the age of the sample in calendar years, expressed as a range of years, rather than a single year, to take into account the uncertainties of the laboratory measurement and the calibration procedure.

Several calibration options exist. However, a calibration that is only based on the laboratory information generates an age estimate suggesting when the dated sample was alive and growing within an animal or plant. This is usually useful information, but in many cases, it does not necessarily relate to the age of the archaeological event of interest.

According to Dye (2009: 108–110), another reason that a ^{14}C date might not relate directly to the age of an archaeological event is that the sample comes from a different, though stratigraphically related, context. This is the case when the archaeological event of interest did not leave behind pieces of plants or animals suitable for dating with the ^{14}C method. An example of this type of event in Ifugao is the construction of stone walls where river boulders were used as terrace-wall foundations, but plant and animal parts were not used. An archaeologist hoping to estimate the age of the structure might recover material older than the structure from the sediment beneath it, or, less commonly, material younger than the structure from sediment that buried it, but there is no material suitable for ^{14}C dating that is directly associated with the construction event. In situations such as these, the archaeologist may use a Bayesian calibration procedure that integrates information about the relative ages of the ^{14}C date and the event of interest, in addition to the conventional ^{14}C age returned by the laboratory.

The ability of Bayesian calibration to integrate chronological information of different

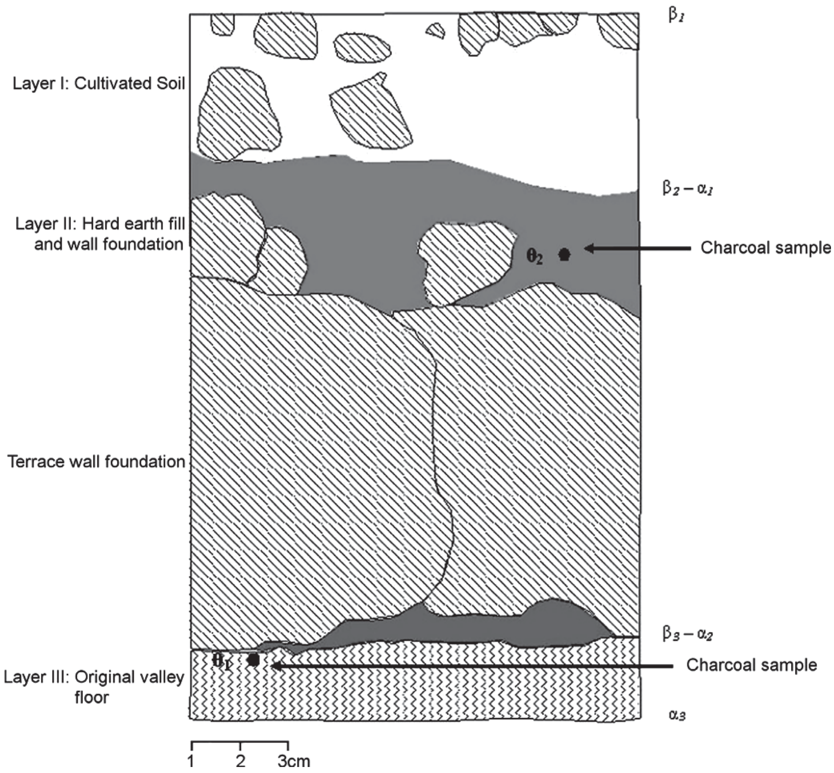

Figure 4 Typical basal profile (vertical section) of an excavated terrace wall.

types provides a powerful approach (Buck *et al.* 1996). Consider the Ifugao terrace construction technique, wherein some layers are made up of earth fill (Fig. 4). Using organic samples taken from earth-filled layers for dating might be invalid because of the high possibility of mixing of materials within different layers. As is the case in this study, there are date inversions (lower layers provided later dates than upper layers) in two excavation units. If we rely on the calibrated information provided by the laboratory, we might have to choose between the two inverted dates and subsequently, get rid of the other date. This option is based solely on the predilection of the interpreting archaeologist, which might not be explicitly addressed in the report of results. Another archaeologist having the same data with different set of predilections will likely choose another option and arrive at a different result. There is nothing in the approach that will help decide whose answer is most likely correct.

In contrast, the Bayesian approach starts with what is known about the relative ages of the two samples and then modifies this knowledge in the light of the ^{14}C dating information. Samples from this report were taken from the layer under the terrace wall and the layer where the terrace wall is located. Since the layer under the terrace wall is untouched (according to Ifugao terrace construction technology), it is safe to assume that the bottom layer is older than the one above it. Using the BCal calibrating software package (Buck *et al.* 1999), the samples yield calibrated ages that agree with their stratigraphic positions (see section on the Interpretation of Chronometric Results). There is no longer a need to resort to *ad hoc* procedures to interpret the results in an archaeologically meaningful way. By taking into account the hard-won stratigraphic information collected in the field, Bayesian calibration yields results that are immediately interpretable (Dye 2009: 110) (note: for a detailed description of Bayesian calibration in archaeology, see Buck *et al.* 1996).

4.1 The Model

In a previous publication (Acabado 2009), I put forward a model in which the construction of rice terrace walls in the Banaue Valley, B_w, is included as a statistical parameter in the calibration of radiocarbon dates obtained from the area. It is based on the Bayesian framework, described in detail in Zeidler *et al.* (1998) and Buck *et al.* (1996) and will not be presented in detail here. Instead, I offer explanations of the model and the way it can be used to make inferences about the construction and use of the Ifugao rice terraces.

The model discussed in this section applies to the datasets provided by excavation units Mamag, Rasa, and Linagbu (no sample was collected beneath the wall at Achao, thus it did not fit the model). In this model, each layer corresponds to a period (the beginning of which will be represented by α variables and the end by β variables): Layer III, initial occupation of the valley, represented by α_3-β_3, with θ_i as the ^{14}C determination; Layer 2, use-date of the terrace, represented by α_2-β_2, with θ_{ii} as the ^{14}C determination; and, Layer I, cultivated soil, represented by α_1-β_1. Given the stratigraphic and ^{14}C information, it is possible to formulate a model of the relationships among depositional units and unknown calendar ages of events represented by two ^{14}C dates (for each unit).

This paper represents the initial Ifugao occupation of the area by α_3 and β_3, with θ_i representing the ^{14}C determination. Since there is no *a priori* information relating to the calendar dates of the occupation, we assume the date of initial occupation lies between 2950 BP, the earliest ^{14}C date from the valley of Banaue provided by Maher (1973), and AD 1868 (Spanish discovery of the valley with significant populations [Scott 1974]). Therefore, following Buck *et al.* (1996), archaeological and ^{14}C information from the terrace layers can be expressed in the following relationships:

$$\boldsymbol{\alpha_3 > \theta_i > \beta_3 > \alpha_2 \geq B_w > \theta_{ii} > \beta_2 > \alpha_1 > \beta_1}$$

(This model was implemented using the BCal software package)

4.2 Interpretation of Chronometric Analysis

It appears that there was an explosion of terrace building in the valley of Banaue after AD 1585 (Table 6). The results of calibration and modeling of this study counter-indicate Beyer's and Barton's hypotheses while supporting Keesing's and Lambrecht's arguments. The Bayesian modeling employed here indicates that the Bocos terrace system expanded rapidly between ca. AD 1486 to AD 1788—a period of approx. 300 years—from the valley floor towards the mountain top. This temporal sequence is also supported by the dates genetated for terrace wall construction. (Acabado 2009) (Fig. 5).

Although only one terrace system was sampled for this study, the ecological setting and

Table 6 Probability of post-Spanish construction of Bocos rice terrace walls

Excavation Unit	Elevation (meters above sea level)	Post-Spanish (Post-AD1585) Probability
Mamag	1040	74.6%
Rasa	1060	98.5%
Linagbu	1340	99.9%

From Acabado 2009: 811

location of the Bocos terrace system is sufficient for suggesting a post-Spanish expansion of agricultural structures in the Banaue area. The working assumption that proximity to water source and lower elevation should be older was based on GIS-modeling, results of interviews with local farmers, and previous ethnographies (Conklin 1967, 1980).

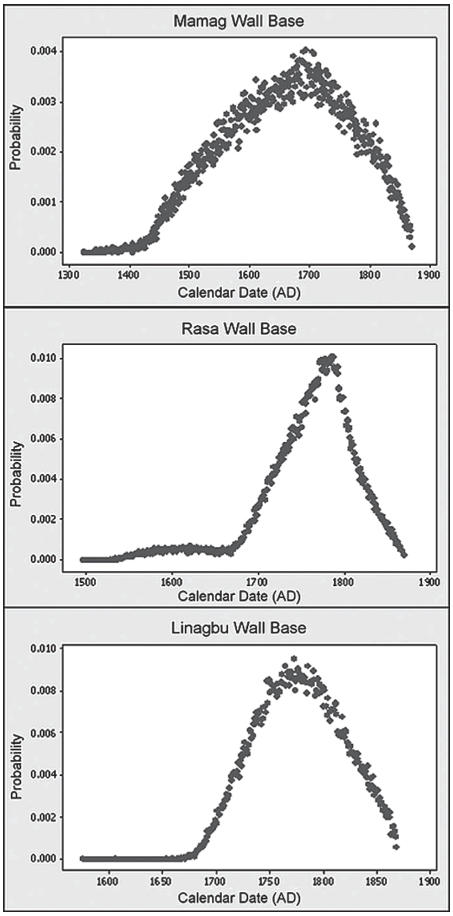

Figure 5 Probability densities of terrace wall construction of the Bocos terrace system (see Fig. 3).

5. Synthesis of Ifugao ^{14}C and TL Dates

Radiometric dates obtained from Ifugao localities show a trend of movement from lower elevation to higher elevation areas and extension from riverine agricultural fields to mountain-top fields. This set of dates suggests that settlements in present-day Ifugao province pre-date the arrival of the Spanish. However, the earlier dates do not imply the presence of irrigated rice agriculture.

Moreover, these dates suggest rapid expansion of agricultural terraces in this set of agricultural districts. The most reliable date for the existence of the terraces, at least in the Banaue valley, is calibrated to AD 1326–1469 (2-sigma). We do not have solid dates for agricultural fields in the Lagawe-Kiangan area, but it is safe to assume that these systems are older than the Banaue terrace systems. GIS data illustrate that environmental conditions in these areas are better for rice production than any other areas in Ifugao.

If we accept Maher's earliest TL date for Kiyyangan Village (820 BP: AD 1130) and ^{14}C dates for Banghallan (1340±375: 176 BC–AD 1338), then there is no question about the presence of settlements in these highland areas before the Spanish push to the northern Philippines. However, the absence of demographic data on these periods adds to the difficulty of recognizing intensification in the construction and use of irrigated fields.

Contact period information, however suggests that fifty years after the initial contact between the Spanish and northeastern Luzon Philippine groups, more than half of the listed (in AD 1620) villages disappeared (Antolin 1789/1970). Villages that were located in the highlands of Cordillera (at least in the Benguet side—listed by the Monforte expedition) were still present in the 20th century (Scott 1974: 175). Antolin recorded a specific case where all the inhabitants of Matunu valley withdrew deeper into the interior of the Cordillera, except for those who converted to Christianity and were assimilated in the lowland towns. Antolin attributes this withdrawal to the establishment of the Fort San Juan Bautista in the town of Aritao, one of the lowland settlements in the foot of the Cordillera Central.

Antolin also attributed the existence of large highland settlements in the Cordillera to the cultivation of irrigated rice and taro as well as sweet potato in swidden fields in all of highland Cordillera. While this large population density could be attributed to certain ecological variables, the cultivation of sweet potato and taro suggest that rice might be a newer introduction to the suite of crops of the Ifugaos. However, these crops might have been introduced at the same time, with later shifts in emphasis reflecting population increase (Gorman 1977).

Among almost all of the Cordillera groups (except the Tinguian of Abra) the wet-terrace agricultural cycle starts in the drier winter season—December or January (Keesing 1962: 323–324). Two factors have been suggested as favoring a winter growing season in the mountains. First, greater control can be exercised over water during the drier winter months (runoff is often torrential in the late summer). Second, by planting the rice in winter, it can reach maturity earlier in the summer, and be harvested before the heavy rains in late summer. Barton explains that there is not enough sunlight during the period of June–December (the usual growing season for lowland rice) to mature rice crops, thus the winter rice growing in Ifugao. Keesing suggests that the upper Magat Valley, with its cool and cloudy winters, and elevation of around 500 meters above sea-level, might be a staging area for varieties of rice suited for mountain cultivation.

Ethnohistoric and ethnographic sources support an eastern Luzon origin of present-day Central Cordillera groups (Acabado 2009: 811, 2010: 168). This dataset, together with recent archaeological findings, suggests a recent rice-terracing tradition in the region. However, irrigated taro might have preceded the cultivation of rice, as proposed by Eggan (1967) and Keesing (1962) and supported by Antolin's and Galvey's observations. In this case, we can assume that wet-rice agriculture started in present-day Magat Valley, and rapidly expanded to Central Cordillera. Reid's (1994) reconstruction of Proto-Nuclear Southern Cordillera indicates that Ifugao and neighboring Bontoc were already wet-rice cultivators when they reached their present-day regions. Terms for pondfield construction, however, suggest local development specific to Cordillera (Reid 1994: 372).

6. Early Taro and Late Rice

There is increasing evidence that taro is an indigenous plant in the Philippine archipelago

(Matthews *et al.* this volume), and the possibility of local domestication must be considered. Informed by previous discussions (Bodner 1986; Conklin 1980; Gorman 1977), and radiocarbon evidence from the vicinity of Banaue, Ifugao, I argue that taro preceded rice in Ifugao terraces. Following the arguments of Barrau (1974: 31–32) and Gorman (1977: 3 29–331) as cited by Spriggs (1982: 12), it seems likely that taro cultivation was favoured in pre-Hispanic Cordillera if the population density was lower then (*cf.* Newson 2009). Given the environmental constraints of Central Cordillera, taro is likely to have been an excellent carbohydrate source for low-density populations in the region, before the influx of lowland refugees (Acabado 2009). As will be discussed later, Peralta's (1982) I'wak study illustrated the relationships between environmental parameters, population density, and taro production. These relationships resonate with the Ifugao chronology in which rice production coincided with population increase.

7. Taro-First Model

The role of taro in Southeast Asian prehistory has not reached the level of importance seen in Pacific archaeology (see Spriggs 2002, 1982). However, the issue of tubers-first in the origins, development, an intensification of agriculture was discussed by Sauer (1952) and modified by Barrau (1974) and Gorman (1977) for Southeast Asian chronology. A focus of this model, especially in Southeast Asia, is the cultivation of taro (*Colocasia esculenta*) and greater yam (*Dioscorea alata*) before the explosion of wet-rice farming. According to Gorman, there might have been a co-domestication of both root crops and rice. This is an apparent move away from the previous model where domestication was seen as a series of events that started with vegetative planting of root crops and culminated in irrigated rice farming (Sauer 1952). However, none of these models could flourish due to a lack of evidence. As Glover (1985) stated, there was just not enough paleobotanical support for a tubers-first model. Even advances in phytolith studies did not produce new information (phytoliths have not been found in taro). Genetic studies, however, provide a better picture (e.g., Kreike *et al.* 2004).

Previously, the introduction of taro and rice in the Philippines was attributed to Austronesian dispersal (Bellwood 1980). This contention is based on the assumed absence of both domesticates in the islands before the appearance of the Austronesians. However, recent information indicates that taro might have pan-South East Asian origins (Matthews *et al.* this volume; Kreike *et al.* 2004) and was around for a much longer time in Luzon (Paz 2001; pers comm., April 2009). Related to this issue is the development of intensive rice agriculture. In contrast to mainland Southeast Asia, where this subject was hotly debated, domesticated rice in the Philippines and the rest of island Southeast Asia has always been considered an Austronesian introduction. If the possibility of early taro cultivation in Luzon is accepted, the models of crop diffusion and agricultural technology development could be revamped.

Tsang (1995) suggested that taro could have been present in the Philippines much earlier than the dispersal of mainland taro agriculturalists. Tissue identified as taro was obtained by Tsang at Lal-lo, Cagayan, and was dated (4875±90 BP [3940 BC–3379 BC]) to a layer earlier than the known arrival of the human populations who had previously cultivated it elsewhere (Austronesian speakers). In the Philippines, the earliest evidence of rice has been dated at ca.

3400±125 BP (2025 BC–1432 BC) (Snow *et al.* 1986). From these limited data we cannot be confident about the dates and sequence of first cultivation of taro and rice in the Philippines.

8. Taro Cultivation in the Philippine Cordillera

Most Cordillera groups are now rice cultivators, whether in irrigated paddy fields and terraces, or in swidden fields. Although the use of root crops, specifically sweet potato, has been emphasized in some areas (e.g., Kankana-ey and the Ikalahan), still, the basic staple and most significant feast food is rice (Peralta 1982: 15). Rice has become an integral part of rituals in the Cordillera and elsewhere in the Philippines. Taro, on the other hand, has become less important. Most taro plots are in small, isolated terraces (see Fig. 1 for example).

The I'wak remains the sole example of a Philippine Cordillera group that cultivates taro as their principal crop. Taro has maintained its ritual significance among the I'wak (though some I'wak communities have become rice cultivators, taro is still at the core of their rituals). Between 1975 and 1980, Peralta conducted an intensive study of their agricultural system, His study can be used to model pre-rice Cordillera.

The I'wak are located in the southern slopes of the Cordillera, in the present-day town of Santa Fe, Nueva Vizcaya (Fig. 1). Spanish documents refer to this group by a variety of names: Yguat, Dumanggui, Aua, Awa, Oak, Alagot, and Dangatan (Peralta 1982: 11). The Spanish first encountered this group ca. AD 1591, and Antolin (1970) wrote in 1739 that they were living in some 30 villages. In 1755, Father Lobato reported that a hostile Awa had about forty-eight settlements and that they occupied 'rugged crags' without even a place to graze cattle or to work fields. He also observed that the principal food of the people was *gabi* (taro), which they planted on the slopes of the mountains, which suggests swidden cultivation.

8.1 *I'wak* Wet Taro Cultivation

Peralta's (1982) work with the I'wak provides us with an insight on the relationship between population size and root-crop cultivation. As mentioned in Spanish accounts, most of the early groups they encountered subsisted on taro and sweet potato. Even when there are rice fields, both of these root crops are still a major part of local diet. In his study of the Ifugao, Conklin (1980: 25, 37) indicated that almost half of the carbohydrates of the Ifugao come from sweet potato (*Ipomea batatas*).

Of particular interest in my study is Peralta's documentation of I'wak wet taro cultivation. Although the group that he documented was also farming a dry variety, the terracing technology might be directly related to the shift to irrigated rice. Wet taro is grown in catch basins, along edges of slow streams, and principally in low terraced fields with constant source of water. When taro is planted, it is relatively independent of rainfall and does not involve a seasonal cycle of cultivation.

The cultivation of wet taro in terraced fields is dependent upon the source of water. Taro terraced-pondfields are usually constructed lower than the water source to ensure constant water-flow (irrigated taro requires regularly flowing water because fields with standing water will rot the corm). If a wider field is built, the higher it will be located on the mountain side, and the farther it is from the water source. In this case, the irrigation canals have to be

Table 7 Peralta's (1982) estimations of I'wak household production of taro and sweet potato

House-hold no.	Member	Wet taro (Ha)	Dry taro (Ha)	Taro yield (wet and dry) (kg)	Sweet potato yield (kg)
1	8	0	.95	559	1955
2	1	.3	.25	2021	7074
3	4	.005	.45	478	1672
4	7	0	.75	580	2031
5	4	0	.75	735	2572
6	3	0	.50	612	2144
7	3	0	.40	588	2058
8	3	0	.60	735	2572
9	1	.09	.32	1507	5274
10	4	0	.20	245	857
11	7	.02	.95	648	2268
12	7	0	.6	464	1625

extended so that the fields can be ponded and the cost of construction and maintenance grows relatively more expensive in terms of labor.

Peralta (1982) studied twelve households in Lab-aw, of which four were farming wet taro (Table 7). The basis for selecting areas for wet taro cultivation rests on the availability of controllable water supply. Controlling water is essential in terraced pondfields because severe flooding can ruin the entire crop. Land must be located in places where water can be drained when necessary and the amount of water flow can be regulated. In Peralta's study, only four households had the ecological setting needed to construct terraced pondfields.

As opposed to wet taro cultivation, dry taro is more widespread. The I'wak practice of *uma* is similar to other swidden practices across the Cordillera, clearing forest lands for cultivation and leaving them fallow. In I'wak, dry cultivation supplies the major part of their taro crop.

The combination of dry and wet taro cultivation among the I'wak provide them with their preferred source of starch. However, according to Peralta's calculations (1982: 51–75), there is still a deficit in taro production. The amount produced does not match household food requirements. The deficit is supplemented by sweet potato *uma* that, arguably, produce a surplus.

Peralta suggested that cultivating wet taro requires less time and effort than dry taro (Table 8). His calculations are based on the amount of time needed to plant the whole field. However, labor requirements for the construction and maintenance of the field were not included in the calculations.

8.2. Ifugao Rice Productivity

The amount of irrigated rice produced in the terraced pond fields of Ifugao depends on different factors (e.g., water supply, type of soil, fertilizer, field maintenance). However, it is

Table 8 Calculations for cultivating wet and dry taro and amount of time needed to feed a household member

Type of Agriculture	Land area (Ha)	Number of work units	Number of work hours	Labour hours (ratio per consumer)
Wet taro (through terracing)	0.415	9	9	1.
Dry taro (through swidden)	6.72	34	128	2.61

Data from Peralta 1982: 54–55

a safe assumption that irrigated rice generally produces more than taro—a yield of 2429 kg/hectare for rice, was reported by Conklin (1980) at Bayninan, and a yield of 273 kg/hectare for taro was reported by Peralta (1982) among the I'wak. Although the capital investment for constructing the infrastructure of irrigated fields is more, the resulting yield is much more stable, for both rice and taro.

9. Summary and Discussion

The idea that taro could be the first staple crop in the Cordillera is not new. Keesing (1962) noted that taro is ceremonially planted even in the coastal Ilocos regions of Luzon because it has religious significance among the Kankana-ey and Bontok. Scott (1958: 90) has also written about the ritual planting of taro to inaugurate the agricultural season in Sagada (Bontok, Mountain Province), and that in the *pun-amahan* (ritual boxes) of the Ifugao *mumbaki* (ritual practitioners), taro stems may be found. The significance has not been explained. Antolin (1970) noted that the larger size of Ifugao settlements implied the existence of taro and rice, the reason why they had not been reduced to the Christian towns.

Physical evidence for the taro-first model, however, remains small. Even this study produced only indirect evidence. However, the ^{14}C dates, ethnohistoric, and ethnographic information fit a model that would give credence to the cultivation of taro before shifting to rice-based farming. If there was little population pressure in the Cordillera before the arrival of the Spanish, then taro and sweet potato could have been sufficient to support the population—as shown by Peralta.

Other ethnohistoric accounts that might point to the development of taro pondfields before wet-rice fields appear in early Spanish accounts translated by Blair and Robertson (1903–1909). These tell of the probable absence of irrigated rice production in Luzon. It was not until 1589, thirty years after the arrival of the Spanish in Manila, that the first irrigation system in the Tagalog area was mentioned (Blair and Robertson 1903–1909: VII: 174; VIII: 252; XII: 210). Similarly, northwest Luzon did not have irrigated rice fields until 1630 in Ilocos and 1640 in Pangasinan (Keesing 1962: 306). Two Spanish accounts (*ibid*) actually took credit for introducing irrigation agriculture in north Luzon (Ilocos and Cagayan). The absence of irrigation systems in the Spanish documents could be attributed to the fact that in the Tagalog, Pampanga, Pangasinan, and Ilocos areas, the planting season begins around midyear, during the monsoon season—a detail that might suggest flood recession agriculture similar to practices in mainland Southeast Asia, especially, Cambodia (Fox and Ledgerwood 1999). On the shores of Laguna de Bay (Puliran then), farmers sowed rice seeds into the overbank flood every year during the time of Spanish contact (F. Zialcita, pers. comm., August 31, 2009).

There is no reason why taro could not have preceded rice as the primary carbohydrate. It is likely that rice gained prominence only after the supposed demographic change, as a result of Spanish contact. Growing taro requires fewer labor inputs than does growing either dry or wet field rice. There would be no benefit in growing rice over root crops (in a purely economical sense). The Ifugao practiced shifting cultivation, a more land extensive practice (that can operate with the same number of workers). They probably experienced less slave raiding (for labor) compared to coastal communities, which are more vulnerable to piracy. The Ifugao did not need to acquire people to farm the fields. Rice does have superior storage capabilities (Spriggs 1982: 13), and is thus better able to support an increasing population. Consequently, when rice and an increased population coincided, rice soon became the main staple of the Ifugao economy. Rice then became embedded in cultural factors that spurred continuance of rice intensification (e.g., the Bulol; status associated with rice-land holdings).

This study suggests that population increase was the main impetus for an intensification of cultivation and shift to a dietary emphasis on rice. Ethnohistoric information suggests that there was a drastic population decrease in the eastern lowland fringes of the Cordillera (Scott 1974: 175; Antolin 1970). Although we do not have concrete data on the probable cause for this population decline, as in other parts of the world, we could attribute this to European diseases and the process of *reduccion* (Newson 2009). These and other factors could have pushed significant populations to take refuge in mountains. Keesing (1962: 49–51, 155–156) and Cole (1922: 243) mentioned the historical movement of Ibaloi and Tinguian/Itneg to inner Cordillera to evade Spanish taxation.

In other parts of the Cordillera, the Spanish recorded villages that subsisted on sweet potato and taro, and did not explicitly mention wet-rice as a farming strategy (Scott 1974; Keesing 1962; Eggan 1967; Dozier 1966). There was no need for a more productive wet-rice cultivation, which needs more labor. The arrival of lowland refugees, however, changed this. The lowland groups were probably rice eaters, which may be supported by present-day Ifugao view (in folklore/religion) that sweet potato is an inferior food source, and that cultivating sweet potato in terraced areas is destructive for the terrace structure (sweet potato was brought to the Philippines by the Spanish, and may have reached the Cordillera quickly, before expansion of Spanish settlement to this interior region).

Anthropological models of intensification usually involve some form of demographic shift (Boserup 1965), though Morrison (1994), Brookfield (1972), and Stone and Downum (1999) questioned the centrality of intensification by population increase. While their criticisms are based on specific examples where intensification occurred even without demographic change, the Ifugao case provides us with proxy indicators for rise of population density.

If the Ifugao already had pondfields for taro, and sweet potato in swidden fields, the shift to wet-rice cultivation could have occurred after the historical arrival of lowland groups. This interpretation is supported by ethnohistory, ethnography, and archaeological chronology.

Implicit in my model is the existence of settlements subsisting on taro and sweet potato in the interior of the Cordilleras. Taro pondfields were then expanded to accommodate wet-rice—this includes expanding the drainage/irrigation system. We could also assume that the social organization of the wet-rice cultivators assimilated the local populations. From taro, sweet potato, and dry rice producing settlements, the increase in population initiated the shift to a wet-rice and sweet potato dominated diet.

Henley's (2002) study on environmental resource and use in Northern Sulawesi and the Philippines presents an example of how intensification might have proceeded with demographic change. Henley (2002: 29) suggests that, at least in historical times, Southeast Asia was never *underpopulated* in relation to available means of production. This might also be true for pre-European Southeast Asia, in readily accessible agricultural regions—as in the Cordillera. Although the Cordillera landscape seems marginal today, past populations that settled and exploited the region might have thought otherwise. They had the technology and means to modify the rugged terrain for intensive and irrigated farming.

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