

THE CO-EVOLUTION OF AGRICULTURAL AND SOCIOPOLITICAL SYSTEMS IN BALI

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ABSTRACT

The oft-studied social structure of ethnographic Bali features numerous kinds of overlapping function-specific actor groups. Understanding the emergence of this pattern should illuminate other cases where relatively mono-hierarchical "chiefdoms" developed into civilizations with different ideological, martial, managerial, and resource-possession power sources controlled by distinct institutions. Lansing's recent ethnographic and computer work suggests that agro-ecological concerns resulting from terrace placement precipitated the self-organization of a yield-enhancing autonomous "complex adaptive system" of water-temple congregations managing ricefield irrigation. This may have forced co-existing extractive polities to change and narrow legitimacy and finance mechanisms. Efforts are in progress to use landscape analyses and archaeological data to evaluate these ideas and to provide dates.

As a research site motivating many virtuosic contributions to ethnographic methodology and ethnological theory, Bali has long been one of the bright points on the map for the world's sociocultural anthropologists. On the maps of most Western archaeologists, however, Bali is much less prominently marked. This is unfortunate, for the availability of an unusually large body of ethnographic work provides a situation in which archaeology has both much to gain and much to offer.

In my on-going research, both the formulation of the problem and the proposed solution have been inspired by ethnographic and historical work done by sociocultural anthropologists. The problem is explaining the development of "theatre states" characterized by a social organizational

pattern that Clifford Geertz has referred to as "pluralistic collectivism," and the solution, or at least part of it, lies in the implications of recent ethnographic and computer work by Stephen Lansing (1991, 1995; Lansing and Kremer 1993), who suggests that a process of self-organization could have been responsible for the emergence of Bali's yield-enhancing autonomous "complex adaptive system" of agriculture-managing water temples. In this article I will put forth the possibility that 19th century Bali's ritual-focused polities and highly heterarchical organizational patterns may in part have been *results* of self-organization processes which occurred among community irrigation societies. The emphasis herein is on model construction, but I will also present some notes on my continuing efforts to evaluate this thesis.

Before continuing to explain what I mean by this, I should point out that I am knowingly presenting a simplification. I do not mean to suggest that change on Bali is monocausal; rather, I am choosing to focus on one particular factor because I hope that it illustrates a type of dynamic that warrants consideration in other archaeologists' models. Moreover, I do not have perfect knowledge of any aspect of the Balinese data. Given this, and in accordance with Balinese custom, I am obliged to ask for indulgence from the seen and unseen inhabitants of Bali, as well as from my readers. If my gambit is successful, perhaps it will add a little to our understanding of how and why societies develop "complexity", in several senses of the word, without succumbing to the totalitarianism of Wittfogel's (1957) *Oriental Despotism*.

SOCIAL ORGANIZATION

Geertz (1980:46), in a formulation quite familiar to those who study Southeast Asia, portrays the nineteenth-century Balinese *negara* as "theatre states" of a primarily "expressive", as opposed to "instrumental," cast, existing

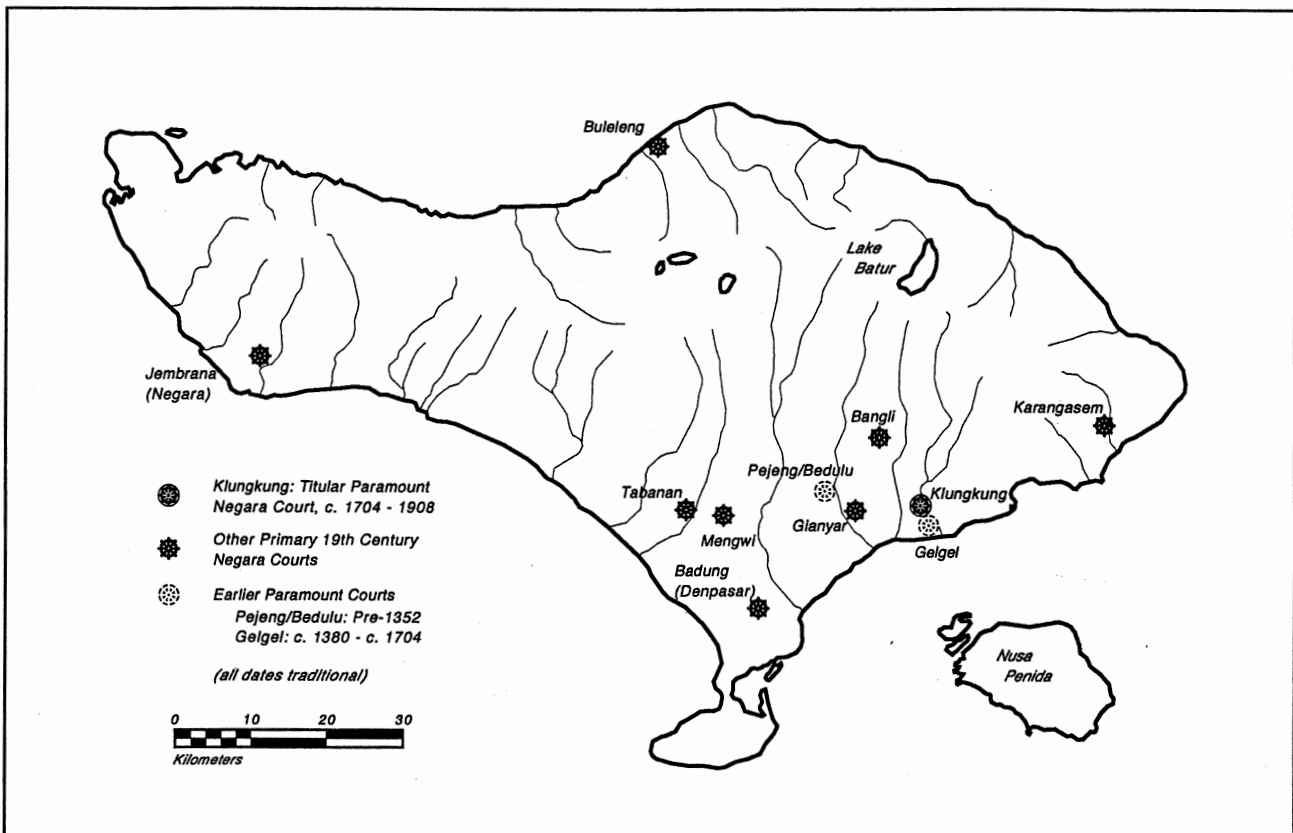


Figure 1: Court centres of pre-colonial Bali.

more to carry out ritual than to provide other services. In accord with local interpretations of Hindu cosmology, the ruler presented himself as the immobile pivot of the universe (see also Heine-Geldern 1956; Tambiah 1976). Beyond ceremonial contexts, these polities were in some ways quite ephemeral: “as there was virtually no staff there were virtually no officials” and “as there was virtually no administration there were virtually no policies” (Geertz 1980a:132). What did exist were power structures centered (as of 1800) around nine royal houses (Figure 1), polities defined not so much as bounded territories but as spatially overlapping “precarious pyramids of traditional allegiances and alliances” (Geertz and Geertz 1975:118), each including “dozens of independent, semi-independent, and quarter-independent rulers” (Geertz 1980a:19; see also Schulte Nordholt 1991:10, 1996:10, 61).

Though some analysts would no doubt object that this cheapens what they consider to be unique about the Indianized kingdoms of Southeast Asia, I nonetheless find it useful to gloss this situation as one in which the political élite, a primarily extractive institution, relies upon the provision of ritual service as its primary source of legitimacy in the eyes of the population – the king’s efforts to save his

subjects from chaos and death included such activities as warfare and disaster relief, but protective, ordering rituals were the indispensable core of the power strategy (Wiener 1995:56, 72-75; Schulte Nordholt 1996:11, 157). This picture of a function-specific polity fits well with Geertz’s more general assertion of Bali’s high degree of what he calls “pluralistic collectivism” (Geertz 1963:83, 1980:48). This is an organizational pattern in which each individual is loyal to many social groups and there is “an independent group for every purpose, and only one purpose per group” (Geertz and Geertz 1975:30). The sorts of groups I am talking about here include voluntary associations such as performance groups, kinship groups, sects, and, more importantly for my purposes, village citizenries and irrigation societies. In what could be described as a heterarchy of power (Crumley 1995), corporate groups with interpenetrating memberships spread over the landscape of Bali “like chain mail” (Geertz 1980a:48), each important group conceptualized as the congregation of a specific temple or temple set.

McGuire (1983), in large part following Blau (1977), has suggested that the concept of “complexity” is a conflation of *heterogeneity* and *inequality*, two variables that are not always correlated. Inequality deals with differential access

to resources, while much of the social differentiation apparent on Bali can be considered *heterogeneity*, which here is taken as referring to “both the horizontal distribution of a population between categorical parameters and the vertical distribution of the population along nominal parameters” (McGuire 1983:101).

In McGuire’s conception, societies are composed of groups which must be integrated into a whole. Putting aside, for today, Barth’s (1993:4) complaint that societies do not exist as bounded “systems of articulated parts,” we find that McGuire recognizes two mechanisms that all societies use to integrate subgroups: the use of nominal parameters leads to *concentric integration* arranging people into “a hierarchy of increasingly inclusive groups” while the use of categorical parameters leads to *intersection*, in which parameters “intersect” on individuals (1983:117). Figures 2 and 3 (after McGuire 1983: Figure 3.4) illustrate the operation of these two types of integration. These concepts give us tools to graphically represent Bali as it is portrayed by Geertz and Lansing. All the examples presented by McGuire depict societies as demonstrating concentric integration along only one set of nominal parameters, but I see Bali as best represented as a case in which *multiple categorically distinct sets of nominal parameters intersect*.

Figure 4 is an idealized depiction of how three of the more important hierarchies of organizational structures intersect to define the group associations of a single individual. Hopefully, the diagram also evokes the way in which group memberships of different kinds overlap to create the dizzying complexity of the “chain mail” pattern noted by Geertz. Each hierarchy has its purpose. The small, independent principalities (*negara*), supported by the heads (*punggawa*) of noble houses, provide pomp and manage warfare. Village governments, responsible for regulation of local security, public facility upkeep, and civil disputes, operate on two levels: *desa* (“village”) and *banjar* (“neighborhood”), and kinship structures (*dadia*) often fit into this system. Finally, irrigation societies (*subaks*), which are responsible for water management, planting coordination, and system upkeep, also fit into a hierarchical structure of irrigation societies conceived of as water temple congregations.

It was Lansing’s portrayal of the functional importance and independence of the water temple system that opened the door to a multi-hierarchical view of Balinese social structure. Even at the highest level, this system exists without reference to either villages or states, ignoring political borders when they do not coincide with watershed boundaries (Lansing 1987:338, 1991:131) and portraying the Jero Gde Duuran of Pura Ulun Danu Batur, the highest-ranking priest at the highest-ranking temple, as an “icon of divinity” (Lansing 1991:92) analogous in some ways to

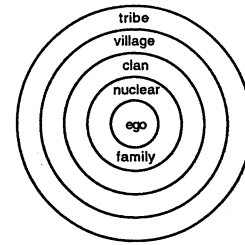


Figure 2: Concentric integration.

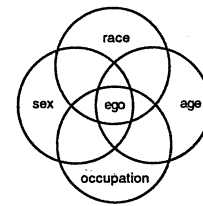


Figure 3: Intersection.

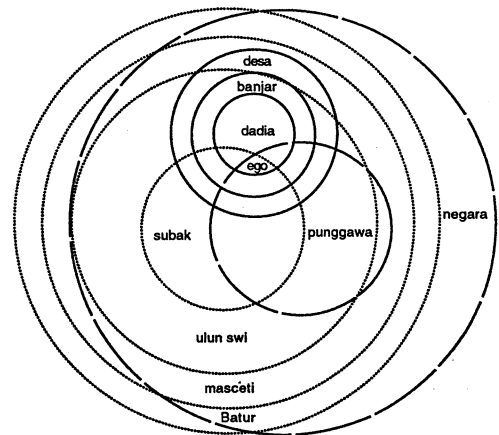


Figure 4: Heuristic simplification of Balinese social structure.

negara kings. The three hierarchies are also non-coordinate at the local level: a *punggawa*’s subjects are distributed throughout the villages of the realm on a houseyard-by-houseyard basis (Geertz 1963:23, 1980a:64), a *desa*’s inhabitants may work the north half of one *subak*’s fields and the south half of another’s, and so on.

IRRIGATION

The system of irrigation societies is central to my purposes here, and, along with other aspects of Balinese agricultural

practice, deserves a closer look. Mean annual precipitation ranges from 1500 to 2500 mm in the relevant areas, with seasonality least marked in the high rainfall mountain areas that feed the rivers (McTaggart 1988). Nevertheless, rice farming on Bali is so extensive and intensive that water is in short supply on the terraced hillsides of this island. Since rice fields must be flooded at planting time and kept relatively dry in the latter part of the growing cycle, farmers can deal with water shortage by staggering the time at which they plant relative to other areas in the same river basin. This impetus to stagger, however, is counteracted by another factor: if farmers synchronize planting, they synchronize fallow periods and wet-dry changes and, since wet and dry fields are ecologically different, they can kill off infestations of wet- or dry-field-specific pests by denying the pests the chance to "jump" to suitable adjacent fields (Lansing 1991).

I will use an idealized case to illustrate the conflict between these concerns (Figure 5). Here, the four letters A through D indicate *subak* irrigation field areas, comprising two irrigation systems within a single watershed. It can be easily understood that A and B need to coordinate irrigation because they are getting water from the same canal; in terms of water demand, it would be best if A and B planted at different times because water needs from rice are cyclic and staggering therefore allows each farmers' group to maximize the amount of water it gets at the time of its greatest need. But there is another dynamic that's going on simultaneously. If a pest that is wet-field specific is introduced when A through D are all planting at different times, the species will be able to move from wet field to wet field through all four of these *subaks*, with population (and damage) levels steadily increasing throughout the progression. On the other hand, if all four *subaks* make their wet-to-dry and dry-to-fallow shifts together, they have a chance of killing off the populations of pests to a greater degree because pests specific to a particular ecology will not be able to move to another instance of the same ecology.

Given these conflicting constraints, there is an optimum size for synchronized blocks of farmers, striking a balance between pest damage and water shortage and thereby maximizing the size of the harvestable crop. Computer modeling of an actual river basin and its waterways and rice fields (by Stephen Lansing and systems ecologist James Kremer: Lansing 1991; Lansing and Kremer 1993) suggests that the Balinese attained this balance, and that the balance is reified on the ground in the structure of their water temple network.

Farmers on Bali are organized into irrigation societies (the aforementioned *subaks*), each of which consists of 50-400 farmers who draw irrigation water from a common source such as a spring, a dam, or a specific branch of a major irrigation channel (usually several kilometers long) shared

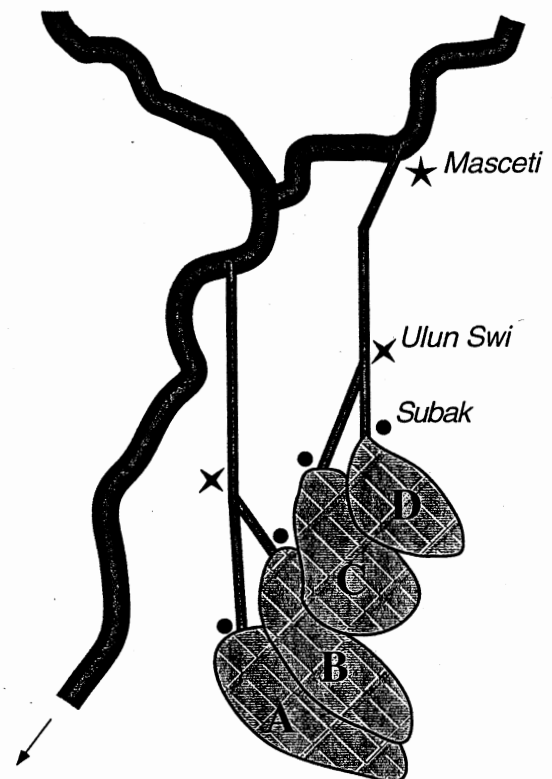


Figure 5: Idealized map of four *subaks* with their associated waterways and temples.

with other *subaks*. The area irrigated varies considerably, but averages about 57 hectares per *subak* (McTaggart 1988:107). Under a leader elected from their ranks, *subak* members meet regularly to arrange cropping schedules, apportion water, and assign communal labor tasks (Lieftrinck 1969; Geertz 1980a, 1980b; Lansing 1987; Barth 1993:72). On Figure 5 I have indicated the *subak* temples of *subaks* A through D with dots placed where these structures are most often found, near the spot where the irrigating canal enters each block of terraces. The *subak* temple congregations form the basic units in a hierarchy of nested groups, under a "hydro-logic" (Lansing 1991:54-55) that links groups using a common water source: a *subak* is responsible for a block of terraces watered from a single canal, an *Ulun Swi* temple may link several *subak* whose canals stem from a common weir or spring, and a *Masceti* temple may link several weirs (and thus a dozen or so *subaks*) that draw from a common stretch of river. Though there is regional variation in the naming of temples at each level, for at least half of Bali the hierarchy culminates in the central mountains at a spot near the lake traditionally believed to be the ultimate source of all

of Bali's fresh water. This is the location of Pura Ulun Danu Batur, The Temple of the Crater Lake. This high temple is frequently called upon to arbitrate water disputes and to give approval and expert advice on construction projects (Lansing 1991:76).

Lansing and Kremer's simulation covered the watersheds of the Oos and Petanu Rivers in Gianyar Regency, modeling 6136 hectares of irrigated terraces divided among 172 *subaks* (Lansing and Kremer 1993:102). The highest irrigated fields lie more than 750 m AMSL; the lowest, 30 km to the south, are at the seacoast. Weirs in the upper reaches of the rivers tend to service only one to three *subaks* while larger downstream water systems can include a dozen or more. Within this region as a whole, it is the Masceti-level temples that traditionally synchronize planting times between member *subaks*, and it is these groups that Lansing and Kremer have found to be of ideal size for the purpose. The achievement of this balance is all the more noteworthy because the "ideal size" for an area of synchronized paddies varies within the studied area, due to local variations in water availability and other environmental factors.

Moreover, Lansing has found that, within his model, a single rule, "copy your neighbor's crop timing if your neighbor's rice yields are higher than yours," produces, over time, a pattern of simulated blocks of synchronized *subaks* that closely matches the distribution of real-world water temple groups in the river basin (Lansing and Kremer 1993). For the initial state of a multi-year simulation of pest populations, water needs, and rice yields, each *subak* in the study area was randomly assigned a time at which to plant rice. For each simulated year, yields were adjusted for the local effects of water shortage and pest damage, and then the "copy successful neighbors" rule was applied to determine each *subak's* planting time for the next cycle. Ecological parameters were varied between runs of the model, but in every run a final equilibrium state emerged after between 8 and 35 years. Average harvests increased substantially (on the order of 100%!) between the initial and final states, but this huge jump in productivity is no more important than the discovery that the resulting stable patches of synchronized *subaks* were remarkably similar from run to run, and actually closely matched the real-world distribution of shared cropping schedules as set by the water temples. For a model with such evolved patches, deleterious changes in environmental parameters (amount of rainfall, virulence of pest infestations, etc.) can be dealt with quite swiftly, with the adjustments to the synchronization patches arising "naturally" through the continued action of the behavioral rule. Lansing and Kremer (1993:110) have pointed out that, as modeled, this qualifies as a self-organizing *complex adaptive system*: one in which

patterned aggregate behavior emerges from the interaction of constituent agents acting to adapt to their environments.

SOCIAL EVOLUTION: THEORY

This finding has significant implications for social theory, since it suggests a mechanism by which the "managerial" concerns (Earle 1987) of a population can prompt development of a complex region-wide service institution, without the coercive involvement of a polity (or any other form of top-down planning) being necessary. Once self-organization processes have created new patterns of similarity and of interdependence, the forces of both mechanical and organic solidarity (Durkheim 1984) should encourage the conversion of social categories into social groups.

Despite the power and wealth which it seems a state could gain by controlling the water temple hierarchy of nested groups (*subak*, Ulun Swi, Masceti, Batur), this system is *not* the cornerstone of a regime of "Oriental despotism." Both Marx and Wittfogel used nineteenth-century Bali as an example of a society where the needs of irrigation created a strongly centralized (bureaucratic and despotic) state; the current consensus is that this is wrong and that on a day-to-day basis individual *subaks* "could regulate their work without intensive applications of coercive power from a centralized state" (Geertz 1980a:82).

Modern experts on Bali do, however, give differing pictures of the degree to which élites were involved with matters of irrigation (Geertz 1980a:68-69; Lansing 1987, 1991:12; Schulte Nordholt 1996:55). All of these scholars have worked by combining ethnographic investigations with studies of Dutch colonial documents, and differences between their conclusions may reflect variation both between colonial sources and between locales or regions on Bali. Writing from his experience in 1880s Buleleng, Lieftrinck pronounced that

the Balinese rulers, although disposed to encourage the opening up of new ground, usually did no more than express a passive interest in such projects or accord certain privileges to those members of the community who were, despite the many difficulties, prepared to undertake the work involved [1969:4].

Lansing, who has worked primarily in Gianyar and near Lake Batur, follows Lieftrinck on this point while adding discussion of the water temple hierarchy, a system whose functional roles Lieftrinck did not trace above the *subak* level (Lansing 1991:25). The independence of the water temple system from the state is shown by the fact that the Temple of the Crater Lake lay in the pre-colonial *negara* of Bangli, while most of its member *subaks* were situated within the realms of other kings. When a war cut off travel between Gianyar and Bangli around 1870, it was the *farmers* of Gianyar who transformed one of their own temples into a "way-

station" for the Goddess of the Lake until the cessation of war allowed them to again travel into the mountains (Lansing 1987:338). There may have been some, largely unsystematic, royal involvement in system construction and water dispute arbitration (Geertz 1980a:65; Lansing 1991:32), but the state remained irrelevant to most management decisions.

Schulte Nordholt, on the other hand, feels that too much emphasis has been placed on the autonomy of the *subaks*, to the detriment of our understanding of the role of the nobility in irrigation (1996:55, 128, 246). While allowing that smaller-scale irrigation did take place without noble intervention, he cites several local traditions that credit the Mengwi dynasty and its satellites with the construction of specific large dams and channel systems, especially during the eighteenth century. Schulte Nordholt claims that élite involvement continued after construction through the activities of the *sedahan*, a class of labor-mobilizing functionaries whose duties included making sure timely repairs occurred, coordinating allocation of water to the *sawah*, collecting a *sawah* tax, and managing those *sawah* areas most directly "owned" by the palaces (*puri*). He essentially argues that the situation could have only been thus:

None but strong *puri* were able to mobilize the necessary manpower and to coordinate the extensive activities required [for construction]. Moreover, the larger irrigation works needed strong *puri* to maintain them. Upkeep demanded as much manpower as did construction, since the large mud dams eroded in fast-flowing rivers and might be wiped out suddenly at the start of the rainy season by a flash flood (*banjir*). In addition, major and secondary conduits and tunnels required periodic inspection and repair, while the entire system had to be guarded to prevent sabotage. All of these factors put together required strong central control from the royal centre or the satellite [1996:58].

Still, this is not "oriental despotism," for it would be an exaggeration to say that there is a "bureaucratic-managerial policy" that "keeps the state supremely strong and the nonbureaucratic and private sector of society supremely weak" (Wittfogel 1957:9). The royal center directly controlled only a fraction of the irrigation systems of the greater realm, while some other large systems were controlled by secondary courts whose loyalty and enthusiasm were subject to change. Thus, "distribution of irrigation water paralleled the fragmentation of control over manpower" (Schulte Nordholt 1996:61).

Rejecting Wittfogel's classification of Bali does not end our involvement with his work, since we may still learn from his discussion of processes. He makes three arguments that are worth mentioning here. First, he suggests that decisions to develop early hydraulic works were "genuine choices" made by pioneers, but ones which carried labor and management demands that required the pioneering farmers

to "subordinate themselves to a directing authority" (Wittfogel 1957:18). Second, Wittfogel claims that such centralized authority inevitably is, or quickly becomes, a power base for political leaders (1957:27, 374). These first two points support Carneiro's negative depiction of this as a "voluntaristic" theory of the origin of the state (1970:733), a topic to which we will return.

Finally, Wittfogel devotes much of his book to the development of centralized despotism. The political economy in effect becomes self-elaborating once the requirements of a hydraulic infrastructure have given it its basic bureaucratic/managerial cast. Centralization builds upon itself, structure causing change in structure. As an account of *how* leaders can maintain and enhance their power once they have seized an initial opportunity for control, this is an excellent example of a "snowballing power" model of history. In this, the image is similar to that of the "maximizing (positive-feedback) political economies" recently held to be characteristic of chiefdoms (though here Wittfogel's conception has often required modification to address the reality and mechanisms of cyclical collapse in such systems [Earle 1978:195, 1991]). The situation on Bali points out another limitation of such thinking – here, élites have failed to methodically exploit some opportunities that would at first glance appear to provide excellent chances for control. When princes involved themselves in matters of agriculture, I suspect that they did not always find that power beget power to the expected degree. Snowballs grow as they roll downhill; we must explain why they sometimes stop rolling.

Aside from the investments made by individual cultivators working their own plots, the operation of an irrigation system requires inputs of labor and material for *construction, maintenance* and *management*. Each of these presents opportunities for ruling élites to enhance the legitimacy of ownership claims, tax collection, and other extraction mechanisms, but these opportunities differ in character.

The evidence presented earlier makes clear that there was élite involvement in construction, perhaps more so in some areas than in others. Princes who created physical infrastructure should naturally receive an increase in standing, and the increased yield would in itself result in an increase in total extractable surplus. Though his evidence is restricted to a limited region (and one that probably was irrigated more recently than the area studied by Lansing), Schulte Nordholt may be right to believe that only the palaces had the social and financial resources to create the larger irrigation systems. However, there are three important caveats to be noted. First, any élite-led construction project would have been collaborative, with labor provided by prospective (and perhaps eager) beneficiaries, and with coordination functions shared with their village-based

assemblies. Second, the traditional histories used by Schulte Nordholt may well have been influenced by nobles' attempts to overstate the role of their class or court. Leach long ago found such overstatement at work in Sri Lanka, where, despite royal protestations to the contrary, the archaeological evidence indicates that "stupendous" tanks, canals, and temples were built by accretion over hundreds of years rather than by massive national mobilizations of corvee labor (Leach 1959:13; Heffernan 1985; see also Korn 1932 cited in Lansing 1991:33). Third, construction by itself is not a source for lasting control – it is a one-time act, and a claim to ownership based on this alone will be weakened over time if future investments in management and maintenance are made by others.

As for maintenance, I expect that state involvement was truly necessary only when dealing with the largest of emergencies. Today, even some of the poorer villages on Bali are capable of constructing and maintaining irrigation systems with limited or no government financial support (*cf.* Jemet 1991), and I see no reason to doubt Liefcrinck's assertion that this was also true in past centuries. Once the initial hurdle of system construction was passed, the improved material and social means of the farmers would give them ability and motive to handle many problems themselves, through non-state institutions and networks. Contributing to maintenance would help a ruler to maintain a claim on a system, but doing so would be a choice, not a requisite for continued power.

The question of who managed the irrigation systems, making the day-to-day decisions on such things as planting cycles and minor maintenance, can be separated from the issue of whether polities were in charge of mobilizations for "great works." Of the three available avenues for investment, management is the most crucial for the model I wish to propose. A government that involves itself in such matters is forced to constantly prove its competence and worth. If the strategy meets with success, the presence of the government appointees will assure that credit goes to the state. But management by hierarchical bureaucracy can also result in inefficiencies and mistakes; under some conditions, the effects on credibility may be lessened or negated by the burden of added responsibility. As Wittfogel himself allows, a ruler seeking his "rationality optimum" will not seek to operate the whole of the economy (1957:48, 128). In the wider world, irrigation systems much larger than anything on Bali certainly exist without state management. From a cross-cultural sample of 15 irrigation systems, Hunt was able to conclude that size bore no necessary relationship to whether authority over internal activities and decisions lay with the state or with the systems' users. This was shown for systems ranging from 700 ha to 458,000 ha (Hunt 1988);

the Kedewatan system, the largest in Gianyar, waters only 3635 ha of *sawah*.

When Balinese states *did* choose to meddle in matters of irrigation, they typically did so through the *sedahan*, whom we have already met in connection with Schulte Nordholt's views. Geertz and Lansing see the pre-colonial *sedahan* as primarily tax collectors whose districts coincided with irrigation systems, and I follow them in minimizing the management role of these officers (Geertz 1980a:69, Lansing 1991:25). No doubt the *sedahan* did at times coordinate repairs and water allocation, but it also seems reasonable to suspect that nobles exaggerated the degree to which their tax collectors served the interests of those they taxed. In sum, the *negara* of pre-colonial Bali provided other services (defense and ritual performance, mostly) and, content to just sit back and collect taxes, left most of the building and management of irrigation systems to the farmers just as they left the regulation of other aspects of life in the hands of village councils.

What I want to suggest in this paper is that the ritual-focused polities and high degree of heterarchy of 19th century Bali may in part be *results* of self-organization processes which occurred among the *subaks*. The "pluralistic collectivism" pattern, it seems plausible to suggest, may have begun at least partially as a result of claims to function-specific autonomy made by farmers self-organizing in response to demands to keep yields high in an increasingly stressed environment. Imagine the gradual (or not-so-gradual) spread of *subak*-sized irrigation systems across a landscape. Initially, both demand for water and pest stress would be low. As more and bigger systems are built, both factors will become more problematic. Water will become critical as large single-canal systems are built; pests will become critical when large areas of closely-spaced fields develop, whether or not they share a common water source.

If one of these two variables becomes critical before the other, either crop staggering or synchronizing could become universal. Barring obstacles born of other aspects of the political economy, this in turn would invite involvement by extractive state leaders as a straightforward opportunity for legitimacy-enhancing top-down management. Actual data on whether and when such opportunities were exploited on Bali will perhaps always remain vague, but if they were, the situation would be analogous to that found in late-prehistoric Hawai'i. The correlation between irrigation and the development of highly stratified societies in Polynesia has recently been called into question by Kirch, but this need not trouble us here since our concern is not with whether dryland agricultural systems produce more expansion-oriented polities but with whether chiefs chose to involve themselves with irrigation when given the chance.

This they clearly did do (Kirch and Sahlins 1992; Kirch 1994:321). For Hawai'i in particular, irrigation systems that "formed the basis for the complex chiefdoms" were managed by chiefly appointees even though the farmers were quite capable of running them by themselves (Earle 1978; Johnson and Earle 1987:238).

On the other hand, the door will be opened for self-organization once the landscape has filled in to a point at which *both* pest stress and water stress have significant impacts on yield, provided that population pressure and/or demands for surplus are such that yield maximization is required. In the jargon of complexity theory, the interplay between two variables here pushes a situation of order (rigid uniformity) or chaos (randomness) to the "edge" that lies between them. Systems that exist within this boundary zone are held to "harbor behavior which is the most flexible, complex, and adaptable" (Kauffman 1993:30, Lansing and Kremer 1993).

I choose to refer to this as a "voluntaristic" theory of group formation, since I see the water temple hierarchy as emerging without the application of coercive force. Carneiro used this term to describe a class of theories of the origin of the state that he rejected because of "the demonstrated inability of autonomous political units to relinquish their sovereignty in the absence of overriding external constraints" (1970:734). However, I am not discussing the origin of a state, but merely the creation of a system of institutions that co-existed with the state. The self-organization mechanism that Lansing describes brings the behavior of individuals or groups "into step" so that group formation is just a matter of unconscious patterns of similarity and cooperation becoming conscious. *Subaks* linked in reified networks become a force to be reckoned with, but they do not replace the extractive state.

Once the threshold is reached and self-organization takes hold, subaks should become more inclined to ignore top-down decrees related to agriculture whenever possible, since such "meddling" would often result in harvest sizes lower than would be found if decisions were made by local groups free to respond to each others' actions. If rulers' status had been dependent on the fulfillment of managerial roles, they would be forced to change and narrow legitimacy and finance mechanisms or to give up some of their centralized power. While the percentage of *per capita* wealth that the state apparatus could extract might decrease as a result of its retreat from management, this would be offset to some degree by the increased productivity of the agricultural sector. An explanation for the Balinese principalities' low level of involvement in agromanagement is, of course, an incomplete explanation for "pluralistic collectivism" and the *negara's* overall non-instrumental character. A strong linkage does seem likely, though, in which the increasing

independence of the *subaks* encouraged and assisted the villages and other groups in assertions of function-specific autonomy.

To recapitulate: increasing density of rice terraces and irrigation systems upon the landscape leads to water and pest stresses, which provide a strong impetus for farmers to encourage and support an autonomous, self-organizing network of social groups, which becomes reified as a water temple hierarchy. This chain of events creates two crises for the polities that must now share the stage with these structures: for one, the emergent structures constitute a real alternative power center in the society, with potential for resisting and weakening the central authority of the state. At the same time, the removal of the state from agricultural management forces changes in power strategies – the state must alter the mix of arguments and actions that it uses to maintain influence over the population (Figure 6).

SOCIAL EVOLUTION: DATA

This paper's main purpose is the presentation of the above model, but a few observations on its fit to the data can nonetheless be inserted here. More thorough investigations are currently underway. The processes I have described would seem likely to correspond with a "turning point" in the development of political forms on Bali. Two such transitions are immediately apparent in Bali's past, one on

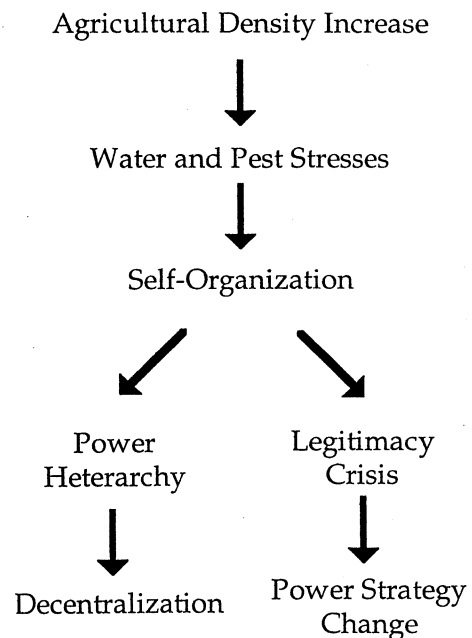


Figure 6: Self-organization in Balinese irrigation management – ecological causes, political consequences.

each end of the span of time referred to as the Early State Period, the time of the first written documents found on the island. I do not yet have a final opinion as to which of these (if either one) saw the self-organization of the agricultural system influencing the evolution of the political system.

The beginning of Balinese history is preceded by what is known as the Early Metal Phase or Period (Bellwood 1997). Data from excavations (Soejono 1979; Ardika 1991; Ardika and Bellwood 1991; Bellwood *et al.* 1992; Tim Peneliti 1994; Ardika *et al.* 1997) and studies of sarcophagus burials (Soejono 1977; Sutaba 1980; Ardika 1987) indicate a people already practicing rice agriculture and engaging in far-reaching inter-island trade networks as early as AD 200, and probably several centuries earlier. The low number of stone sarcophagi found (just over one hundred for the entire island) has been used as evidence that access to status markers was restricted, and this in turn has been used to infer a "chiefdom" level of social stratification (Lansing 1983a; Ardika 1987:6, 45). Direct or indirect contact with India is indicated by the presence of pottery from the subcontinent, but the character of the society remained Austronesian. I posit that the politics of this period were kinship-based, dependent upon "instrumental" legitimacy – in actions of import to the subjects (possibly including agriculture) rulers were expected to provide useful guidance in decision-making and cooperation (re. Java, see Van Setten van der Meer 1979:53).

State-level social organization, or at least evidence thereof, arrives with a bang. From copper plate and stone inscriptions that start to appear near the end of the 9th century AD, we suddenly learn that Indianized kings have begun to decree the rights and obligations of specific villages and that wet rice irrigation technology is in existence (Lansing 1983a; Ardika 1987, 1994; Bernet Kempers 1991; Setiawan 1995); iconographically complicated sculpture and monumental architecture arrive close on the heels of the inscriptions. To thus reduce "Indianization" to an event that happened at a single point in time is undeniably a simplification that ignores the time and energy required to "convert" the populace. Adoption of (modified and localized) components of an Indic worldview has been (and is) very much a *process* on Bali; it had already started when the first inscriptions were written, continued throughout the Early State period, and continues today. As the inscriptions make clear, performing arts groups, often sponsored by the courts, have long been among the most enthusiastically received vectors (Lansing 1983a, 1983b). All that having been said, the nigh-simultaneous appearance of several distinct categories of material culture does suggest that Stutterheim's (1935) Hindu-Balinese Period – the first centuries of what I am calling the Early State Period – was a

time of exceptional change and exceptional receptivity to outside ideas.

The 11th century is perhaps the "height" of the Early State florescence. While some of the earlier inscriptions and monuments show more Buddhist influence (Sutaba and Seriasa 1984; Bernet Kempers 1991:99), by this time the mix of imported ideological elements had shifted somewhat towards Hinduism. Bali's most impressive monument was likely built in this century: Gunung Kawi, a complex of ten *candis* (royal memorial temple reliefs) cut into the living rock and averaging over ten meters high (Patt 1979; Adri and Rata 1990:18). The *candis* are accompanied by over twenty small rock-cut chambers taken to be cells for monastic caretakers. The whole complex gives an impression of considerable royal power, and is consistent with the idea of an ancestor-worshipping "cult of deceased kings," a concept for which Stutterheim also found support in inscriptions and statuary (Stutterheim 1935:23; re. Java, see Pigeaud 1962:481, Soekmono 1971:16, 1995:7, Klokke 1994).

The term "*subak*" is also first mentioned in inscriptions from the 11th century (Ardika 1987:56), but much remains to be learned about the productive and religious roles of these institutions at, before, and after this date. As in later periods, limited royal involvement in waterworks can be seen during the Early State period, though we cannot be sure of the degree of elite exaggeration of claims of leadership and control. A fragmentary 962 AD inscription makes reference to a king ordering the repair or improvement of a dam that suffered annual flood damage (Manukaya (No. 205): Goris 1954:197; Ardika and Beratha 1996:112). This specific inscription does not mention irrigation, though the current dam in this location (in Tampaksiring, Gianyar) does water over 200 hectares. Irrigating may have been of secondary concern; the text of the inscription implies that the primary purpose of the dam was to support a holy bathing place.

The shift to an Indic ideology at the beginning of the Early State period could have been a power strategy change instituted to deal with emergent agricultural self-organization, but centralization of power was, if anything, increasing at that time. The course of events after the 11th century would seem a better candidate for the transition I am seeking. *Candi* construction never again reached the level of grandeur seen at Gunung Kawi, and seems to have ended altogether by the 14th century (Bernet Kempers 1991:44). While the *candi* temples had been located deep within ravines, what continued on were open-courtyard temples for the most part located in easy-to-reach places. Such temples had also been in use during the Early State Period, and can be seen in Javanese reliefs from this period (Stutterheim 1935:18). Some "megalithic" Balinese courtyard temples have even been proposed to be of prehistoric date

(Soejono 1962; Bernet Kempers 1991:15), though these claims are difficult to assess because the simple technologies used in their construction certainly remained available in later centuries. Even so, the end of monumentalization amounted to a distinct change in the mix of strategies of "materialization" in use (DeMarrais *et al.* 1996), signaling not only a shift of emphasis from mass to space, but also a net increase in accessibility that would enlarge the potential for public viewing and participation in royal ritual. Elaborate and costly hidden shrines were perhaps a luxury that could no longer be afforded by kings who needed to put more energy into convincing the masses of their worth as rulers. (For a companion case in which temple form shifted so as to *limit* public participation, see Kolb (1994) regarding Hawai'i.)

According to the epic *The Nagarakertagama*, Bali was invaded by the Javanese Majapahit Empire in 1284 and again in 1343, though it regained its independence, by stages, shortly thereafter (Pigeaud 1960:48, 54, 1962:526; Bernet Kempers 1991:46). A weakened polity in Bali may have provided an easy target, and the subsequent upheaval may have been instrumental in the instigation of the power strategy changes that helped later rulers co-exist with autonomous villages and *subaks*. By the end of the 14th century royal edicts were no longer being recorded in permanent materials, a change that could reflect a reduction in centralized power, a shift to a less-managerial "expressive" legitimizing ideology, or both. Over the succeeding centuries, the core region of southern Bali seems to have become increasingly ungovernable as a single entity. By the middle of the 17th century (if not earlier) the once-supreme Balinese court at Gelgel had seen its realm effectively split into several rival principalities (Agung 1991:7; Schulte Nordholt 1996:25).

On another front, evaluation of the model requires improvements in our understanding of the timing of the spread of irrigated rice agriculture across the landscape of southern Bali. This is because the self-organization mechanisms described by Lansing are propelled by water shortages and pest threats whose intensity is dependent on large numbers of farmers and fields operating close together. Unfortunately, archaeological evidence for the age of fields is not easily gathered, especially on the scale needed to reconstruct such details of past land use over a large and varied area.

On the expectation that ease of irrigation is predictive of age, I am in the process of rating the several dozen existing irrigation systems of the regency of Gianyar by the length of their tunnels, by the ratio of channel length to total irrigated area, and by other topographical and environmental variables. The rate of change and the plausibility of the landscape "retro-diction" scheme will be checked by comparing the resulting patterns with other landscape

analyses and with the spatial distributions of various classes of sites of the last two millennia. Locations of some site types – sarcophagi, *candi*, places mentioned in inscriptions, and so on – have been cataloged by other investigators (mostly Indonesian or Dutch); Bali has not to date seen very much systematic survey for habitation sites (see Ardika 1993 for an exception), though it is hoped that a joint Indonesian-international project will soon be able to address this lack. Another basis for extrapolation to the wider agricultural landscape, or a check on reconstructions built from other lines of evidence, can be provided by localized soil coring and profiling investigations. Attempts are being made to assess the age of specific wet-rice terrace sets through sediment, pollen, and phytolith analyses carried out on carbon-dated contexts (*cf.* Scarborough *et al.* 1998, *in press*). As usual, much work remains to be done.

A FINAL NOTE

I have presented this paper in the hopes that others will find useful this example of how self-organization dynamics can be integrated into the sorts of "ecosystem approach" flow-charts with which archaeologists are so familiar. Perhaps this goes some way towards addressing the concern of Brumfiel (1992) and others that such models often deny non-élite actors any active role. Realizing the potential of self-organization may also help us build social process models that go beyond description of "positive-feedback" maximizing political economies in which power tends to become ever more concentrated, to show how a society, once started down such a track, can change direction.

The kind of balancing-act optimization system that I describe for Bali can emerge without being ordered into existence to serve an élite, and can resist co-option once it forms, especially if the system increases productivity. This kind of thing may also have happened elsewhere in the world, and not necessarily in the agricultural sector. For example: to go far beyond my region and time period, Yoffee (1993:65) has written that Mesopotamian societies

were composed of partly overlapping and partly opposing fields of behavior – especially as represented in the competition between temple and palace estates and the interests of the "community," i.e. those traditional kin groups and non-traditional economic corporations (for example, traders) that were not strictly dependent on temple or palace.

This characterization has notable resonance with the "pluralistic collectivism" view of Bali developed above. Of power have been showing up of late (Mann 1986:22; Yoffee 1993; DeMarrais *et al.* 1996; Earle 1997), and are quite valuable tools when analyzing such situations. For now, however, it is enough to say that both the Balinese case and the Mesopotamian case (and doubtless others as well) indicate

the presence of multiple types of institutions, each supported by a different mix of ideological, martial, managerial, and resource-possession power sources. Because he considers this pattern of multiple power structures to be so distinct from the power structure reputed to exist in chiefdoms, Yoffee (1993:67) feels that

From just about any kind of chiefdom to a Mesopotamian state you cannot get – either gradually or with an evolutionary punctuation mark.

Models developed for Bali may help us understand how we *can* get from more monolithic, centralized power to the kind of situation Yoffee suggests existed in Mesopotamia. Though every local case will of course be different, perhaps such models will prove useful to others working in Southeast Asia, as well.

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