

Wadley, S., ed. (1980) *The Powers of Tamil Women*. New York: Maxwell School of Citizenship, Syracuse University.

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Digitizing 'Development'

Balinese water temples, complexity and the politics of simulation

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Abstract ■ This article examines a recent use of computer simulation in modeling the ecological dynamics of a rural indigenous community. It takes as its central example anthropologist J. Stephen Lansing's models of irrigation patterns and practices in Bali. Lansing first put together computer simulations of Balinese water temple networks to demonstrate the wisdom of traditional modes of organizing agriculture and to draw attention to the folly of Green Revolution development projects. Lansing argued that his modeling could provide a tool for more culturally appropriate development, but I argue that his project may continue some of the neocolonialist premises of development programs more generally. As it turns issues that are very complicated politically, economically and socially into bounded technical problems amenable to computational solution, it erases internal community politics and ignores the local and global political economic context in which communities exist. Lansing's simulation accomplishes this in part by reviving the premises of an ahistorical cultural ecology in which communities are conceptually collapsed into 'nature' – where nature is understood to be a system seeking homeostasis. This article examines the claims Lansing makes for his simulations and locates these within a political economy in which imperialist and neocolonialist domination has often been serviced by control over technologies of representation. After discussing Lansing's work, I comment broadly on the trend toward using computer simulation in social planning, and reflect on what this might mean for continuing projects of 'development'.

Keywords ■ Bali ■ computer simulation ■ development discourse

A Balinese high priest in 'traditional' dress is sitting in front of a Macintosh computer, studying a simulation of the irrigation networks that he manages as a member of the Hindu priestly caste responsible for water allocation in rural Bali. He is on a verandah overlooking a complex of temples dedicated to the Goddess of the Waters, and he is listening to USC (University of Southern California) anthropologist J. Stephen Lansing explain how the simulation works. Also present at this meeting are systems ecologist James N. Kremer, who helped Lansing program the simulation, as well as some local bureaucrats in charge of irrigation and farming projects for the

nation-state of Indonesia. These last people are ostensibly on hand to see whether the simulation might offer a way for Indonesian irrigation officials to communicate with indigenous Balinese farmers and priests about the management of irrigation for terraced rice farming.

The film from which this image is drawn, *The Goddess and the Computer* (1991a), chronicles J. Stephen Lansing's and James N. Kremer's attempt to prove through computer simulation that 'traditional' modes of Balinese irrigation are better suited to the landscape and indigenous culture of the island of Bali than the technocratic agricultural innovations introduced into Southeast Asia by the 1960s and 1970s 'Green Revolution' (see Lansing 1991b, 1995; Lansing and Kremer, 1993, 1994). In this article, I examine Lansing and Kremer's hopes and claims for their computer model and argue that they inadvertently recapitulate some problematic premises of Green Revolution development discourse and may well find their simulation used to promote practices that perpetuate neocolonial relations between Bali and more economically powerful polities and agencies. My aim is to use Lansing and Kremer's model as a lens through which to examine recent alliances between cultural anthropology and the sciences of chaos and complexity, particularly as these have been forged through computational models of social dynamics (see also Gessler, 1994; Gunerman and Gell-Mann, 1994; Axtell and Epstein, 1996; Tainter and Tainter, 1996). In the digital age, such models may become increasingly attractive tools for social analysis; indeed, they have already caught on in some policy circles (see the concluding discussion in this article). I seek to add a word of caution to those who would employ the technology of simulation to modeling and understanding complex social reality. Simulation can be an excellent tool for examining social scientific assumptions, but can also obscure these very same assumptions, hard-wiring them into the most basic parameters of a model.

The Green Revolution was an international agricultural initiative aimed primarily at 'developing' countries and designed to raise crop yields and vigor so that widespread famine in these parts of the world might be averted, and, not incidentally, so that these countries, through producing a surplus using technologies and knowledges generated in and purchased from the First World, might reap the 'benefits' of being integrated into a world economy – benefits that would include having extra moneys to invest in the necessary accoutrements of modern nation-states: schools, hospitals, armies, etc.¹ Critiques of the Green Revolution (see Gibbons et al., 1980; Feder, 1983; Glaeser, 1987; Shiva, 1991; Escobar, 1995; Gupta, 1998) have drawn attention to how the importation of Western agricultural technologies has promoted increased proletarianization among the peasantry; exacerbated inequality by concentrating wealth and credit in the hands of the already rich; aggravated global patterns of dependency on First World capital, expertise, agencies and technologies; wrought havoc on the environment by introducing new and often ineffective chemical pesticides,

fertilizers and high-yielding genetically engineered hybrid seeds (supplied by large multinationals); and jeopardized the livelihood of small farmers who have been encouraged to produce categories and quantities of goods according to the exigencies and schedules of global food markets.²

In his narration of *The Goddess and the Computer*, Lansing argues that computer simulations of Balinese water temple networks can demonstrate that indigenous agricultural practices are quite effective in generating healthy and adequate rice yields. A.J. Michael, following Lansing, describes the system in question:

This complex system of irrigation and water management, which has been a functioning ecological system for over one thousand years, is controlled by members of the Brahman priestly caste. The authority of the temple is based on the belief that water is a gift from a goddess and must be shared. (1990: 19)

This gift is allocated through an elaborate system of rivers and temples which directs the flow of rain and lake water down terraced mountainsides. Farmers get water through a local temple subordinate to the temple atop the mountain. The whole arrangement is precisely calibrated to religious beliefs about the Goddess of the Waters.

Lansing's project is meant as a constructive critique of the Green Revolution, a concrete project of recognizing and promoting indigenous agriculture as 'appropriate technology'. The Green Revolution saw traditional techniques of agriculture as wasteful and inefficient³ and envisioned the elimination of the distributed temple system in favor of treating small groups of farmers as autonomous units. Lansing aims to show that traditional Balinese systems of water temple networks are in fact effective and economical. The computer simulation is designed as a didactic tool to convince otherwise skeptical engineers, bankers and development officials that traditional cultural practices of agriculture are not only feasible, but exhibit a sort of 'evolutionary' – even 'natural' – wisdom. This wisdom is revealed through the powerful medium of the computer, whose symbolic association with the values of modernity rubs off on the traditional practices it models. Lansing hopes the simulation can broker a cooperative relationship between Indonesian agricultural officials and Balinese priests and farmers.

Lansing's work makes use of simulation technologies developed in the service of the sciences of complexity, a suite of enterprises premised on the notion that diverse natural and social systems – biologies, ecologies, economies – share a common set of organizing principles. In the vision of the sciences of complexity, all of these different systems exhibit nonlinear dynamics, processes in which the aggregate adaptive actions of individual agents (be they cells, animals or economic actors) lead to globally unpredictable, complex emergent patterns. Though Lansing is professionally located in the world of anthropology, some of the most favorable responses to his work have come from practitioners of the sciences of complexity. I

first learned of Lansing's work in 1992 at a conference on Artificial Life, a field dedicated to the computer simulation of biological and evolutionary systems. At this gathering, Lansing was concerned to demonstrate how tools developed to study evolution could be applied to the study of cultural change, adaptation and continuity. His talk was tremendously well received, as it argued that the technology of Artificial Life might be used in the service of indigenous knowledges, affirming their age-old and 'ecological' elegance in the face of overly bureaucratic and technologized projects. Many people in the politically liberal audience were encouraged at the suggestion that their science might be used to dismantle overblown and repressive governmental programs. Lansing was concerned with understanding 'humanized nature' and with appreciating the role of human cultural agency in the historical transformation of the rural landscape in Bali. I will argue that in spite of his best intentions, Lansing's modeling methods leave aside some very crucial sorts of human agencies – agencies that have shaped the wider politics of the irrigation system and that may shape the reception of the simulation itself.

The collapse of social reality into nature and the persistence of stereotypes of 'oriental', indigenous and peasant societies in the silicon age

Lansing arrived at the Artificial Life conference prepared to convey his story in the jargon of complexity and evolution. He explained that the simulation 'assumes that the domesticated ecology of Balinese rice terraces is the product of a stochastic evolutionary process, in which each generation of farmers seeks to maximize harvest yields by reducing losses due to water stress and pest damage' (Lansing, 1992; see also Lansing and Kremer 1994: 201). The simulation takes as input 'assumptions about rainfall, rice growth and pest dynamics and then simulates a year of growth'. These assumptions are fed into different farming strategies for village-sized irrigation units called *subaks*. 'Those subaks do best (have the highest fitness payoff) that integrate themselves into the temple system that coordinates irrigation and farming schedules. The results of many simulations reveal that: 'the temple system . . . has evolved to respond efficiently to external perturbations' (changes in rainfall, pest presence, etc.) (1992, see also 1995).

As with any simulation of a complicated social process, Lansing's leaves out a great many factors that may well have a bearing on how the real system operates. Nonetheless, the omissions are very telling: they direct us to the image of indigenous Balinese society with which Lansing works. Lansing depends on a social theory in which 'modern' and 'traditional' modes of farming can be neatly separated.⁴⁵ This allows him to take 'traditional' modes as autonomous systems potentially free of entanglements in larger

political and economic processes – and perhaps even free of internal conflict. This invites him to romanticize 'traditional' Bali, and to do so by imagining 'traditional' practices to be perfectly in sync with the 'cycles of nature' (1991b: 138) – where nature is understood as a rationally ordered system tending toward homeostasis. There is, of course, a long tradition – in both anthropological and tourist literatures – of imagining Bali as a place of tranquility, as 'harmonious, apolitical, and peaceable' (Robinson, 1995: 304), as a 'timeless, unchanging place, isolated from the rest of the world' (Vickers, 1996: 7). This image is serviced in part by the fact that, of Indonesia's 27 provinces, Bali is the only one in which an island, an ethnic group, and a language map on to one another; in all other cases, a province includes many islands or is only part of a larger island. As Adrian Vickers notes, 'the view of Bali as somehow apart or cut off from the rest of the archipelago is largely a colonial construction, a combination of divide-and-rule policies and the idealization of Bali as a cultural paradise' (1996: 8). The isomorphism between Bali as an administrative region and as a culture area invites the erasure of political and cultural history, and this erasure in turn invites the collapse of the region and its people into 'natural' history. In their article in *Artificial Life III*, Lansing and Kremer argue that their simulation 'focuses on the effects of human agencies in reshaping ecosystems' (1994: 203), but these human agencies are in fact submerged by a vision of Balinese water temple networks as kinds of complex adaptive systems, as systems amenable to naturalistic explanation.

Lansing's simulation of the domesticated ecology of Balinese rice terraces as 'the product of a stochastic evolutionary process in which each generation of farmers seeks to maximize harvest yields' envisions 'the Balinese' to have engaged in 'traditional' farming practices generation after generation, in a timeless cycle of repetition. In setting the ethnographic stage for his simulation, Lansing states that 'For over a thousand years, generations of Balinese farmers have gradually transformed the landscape of their island, clearing forests, digging irrigation canals and terracing hillsides to enable themselves and their descendants to grow irrigated rice' (1992; see also Lansing and Kremer, 1994: 202). In his book *Priests and Programmers*, he writes:

... for the Balinese, nonlinear patterns of temporal order emerge from the regular progression of natural cycles, the seasons of growth and change. When Balinese society sees itself reflected in a humanized nature, a natural world transformed by the efforts of previous generations, it sees a pattern of interlocking cycles that mimic these cycles of nature. (1991b: 133)

Anthropologist Akhil Gupta has pointed out that orientalist (and primitivist) portraits of non-Western societies are often built on the idea that these societies are ordered by circular conceptions of time radically other to the West's progressive and linear time (1992). Often this is accompanied by a sense that these societies are somehow 'closer to nature'. Indeed, in

his discussion of cyclical time, Lansing writes that: 'The Balinese, one might say, have a biological view of time, in contrast to an industrial one' (1991b: 12). Gupta points out that such views of the 'time' of the 'other' have been instrumental in 'the civilizing mission of colonialism and the developmental mission of neocolonialism' (1992: 192). The non-West is posed as immature, in need of paternalistic guidance: 'the allochronism of development . . . presents to the West an image of itself at an earlier stage of its life cycle' (Gupta, 1998: 41). But where these images were previously used to show why the 'East' had difficulty growing into the cumulative and progressive time of modernization, Lansing scientizes such images to show their deep 'natural' rationality.⁶ Even if he values this Edenic rationality, however, Lansing's computer model still depends on and implements a romantic vision of the cyclical time of the other, and brings stereotypes of 'oriental', indigenous, and peasant societies into the silicon age.

The nature into which the indigenous Balinese are collapsed is one freighted with assumptions about rationality, one that might best be characterized as descended from the European and US American evolutionary science that developed in concert with liberal political theories of possessive and competitive individualism. 'Generations of farmers . . . maximize harvest yields by reducing losses due to water stress and pest damage' (Lansing, 1992). Lansing tells us that the outcome of farmers' actions generates a 'fitness payoff' for their subak. The individual embedded in this system is understood to tidily maximize benefits and minimize costs, much like the individual in neo-Darwinian theory that maximizes fitness as it seeks to reproduce its genotype into the next generation. Affairs are a bit more complicated than this, however, since in Lansing's model 'fitness' can only be maximized by cooperating with other subaks in the network, not by acting as though each subak were autonomous. This coevolutionary notion of fitness directs our attention to the whole network as the evolutionary system and thereby buries social phenomena still further in naturalistic language. This is a nature both fully romanticized and fully amenable to scientific and computational understanding as a 'complex adaptive system', in which actions of individual agents lead to nonlinear aggregate outcomes (see Lansing and Kremer, 1994: 217–18).

And it is a nature clean of politics; 'fitness payoffs' and crop successes are accomplished by struggling only against predictable and objective natural forces (pests and water scarcity) – or by working with cultural forces that are themselves understood as coextensive with natural processes: in Lansing's tale of the Balinese priests who administer the water temple networks and officiate at the important water rituals, he characterizes them as 'making Lamarckian choices'. Lamarck was an early evolutionist who proposed that creatures might affect the trajectory of their species' evolution by passing on phenotypic traits acquired in their lifetime. Lansing's reference to Lamarck here (rather than Darwin) is an attempt to introduce intention and agency into the historical processes he seeks to model, but

his continuing commitment to biological idioms keeps these processes leashed to an evolutionary logic. All of the social agencies involved in 'traditional' agriculture become part of a process that can be understood to arise 'naturally': 'We have shown that the structure of water temple networks could have developed through a process of spontaneous self-organization, rather than deliberate planning by royal engineers or other planners' (Lansing and Kremer, 1994: 220).⁷ While it is perfectly plausible that no one involved in the system planned the whole thing, Lansing's phrasing of the issue goes too far toward deleting the politics that may have been at play, and toward eliminating any non-biologized intentionality – individual or collective – on the part of the people whose culture he is describing (see Eglash, 1997, on the erasure of intentionality in much mathematical anthropology). Some of this comes from his eagerness to see these networks as complex adaptive systems, but it also continues an older tradition of such biologicist description in the anthropological approaches associated with cultural ecology (as in the work of Julian Steward, Leslie White and Marshall Sahlins. Lansing and Kremer cite as precedent for their approach anthropologist Roy Rappaport's work on understanding ritual systems as elaborate levers for maintaining ecological balance [see Rappaport, 1967, 1971]). Even as Lansing breaks with dominant figurings of indigenous knowledges as backward, he continues to measure the value of an agricultural social system in terms that privilege economic efficiency.⁸

In *The Anti-Politics Machine*, anthropologist James Ferguson argues that 'development' projects like the Green Revolution have operated through depoliticizing social problems. As 'anti-politics' machines, development apparatuses are 'everywhere whisking political realities out of sight, all the while performing, almost unnoticed, [their] own pre-eminently political operation of expanding bureaucratic state power' (1990: xv). While Lansing's project could be viewed as a socially sensitive challenge to the usual practices of development, it also continues some of the 'anti-political' premises of the Green Revolution itself, for even as it reverses Green Revolution visions of indigenous agriculture, it produces an 'anti-political' frame for these visions through deploying a cultural ecology that imagines indigenous and rural communities as governed by rationalities in harmony with the rhythms of nature. This frame channels issues that are very complicated politically, economically and socially into bounded technical problems amenable to computational solution.

Of course, whether Lansing's project functions in a practical sense as a continuation of the projects of development is far from clear. Where development projects like the Green Revolution had an enormous amount of money, bureaucracy and multinational corporate interest behind them, Lansing's project is quite small, and Lansing, while articulated to a large university, is an individual with relatively little power to effect far-reaching transformations in Balinese life. If Clifford Geertz's early work on Indonesian agriculture, *Agricultural Involution* (1963), had agendas in common

with the national security apparatus (John Gledhill, personal communication) (using a cultural ecological approach to demonstrate to policy makers how traditional beliefs and histories might be interfering with top-down projects of development), Lansing's work is meant to be advocacy work for indigenous Indonesians. His motivations are not at all the same as those of the institutions responsible for the problems he is attempting to fix. He is hardly at the helm of a giant anti-politics machine, ideologically or financially, even if he has garnered some monetary support from international agencies, most notably the United Nations Food and Agriculture Organization. His activities might rather be understood as small moments in the production of a distributed and dispersed network of practices that reinstall in more complicated ways some of the patterns of dependency and relations of inequality that have characterized neocolonialism. To begin to see how this might be so, I turn to how Lansing hopes to route his simulations into the Balinese context.

The simulation and its supporting technology in political context

If Lansing and Kremer oversimplify history and power relations in their simulation, their attempts to introduce their simulations to irrigation officials, bankers, water temple priests, and farmers also exhibit a systematic amnesia about how colonial, postcolonial and Green Revolution histories have fundamentally informed the dynamics of power within which Balinese temple priests and their congregations of farmers exist. Lansing and Kremer designed their computer simulation in the hope that once a clear picture of the rationality of the water temple system was available, Bali Irrigation Project administrators, Indonesian tax officials, Asian Development bankers, Balinese high priests, subak heads and peasant farming families would be able to see eye to eye.⁹ And indeed, the simulation has gotten some recognition from state irrigation bureaucracies (Lansing, 1995). But Lansing frames conflicts of practices as problems of communication rather than as struggles to enforce or dismantle social inequality – a framing that reinforces the depoliticization that his simulation effects. And he does not attend to the many agendas' cross-cutting concerns with irrigation. Nor does he actively seek out ways to articulate his project with local resistances that may already be under way and that are always part of any unfolding of 'development' projects (see Gupta, 1998).

Lansing's view of the issue as 'apolitical' is indexed by his assertion that 'For the Balinese, irrigation is a religious matter, outside of politics', and that 'The power of the temple is not based on force but on religious faith, the idea that water is a gift from a goddess and must be shared' (1991a). While we might well question our understandings of what should count as 'political', I think Lansing takes this point in the wrong direction. His claim

that the power of the high priest 'in the visible world ultimately stems from his relationship to the Goddess of the Lake, in the realm of the immaterial' (1991b: 82) sounds oversimplified when we learn later in *Priests and Programmers* that this priest – selected by a priestess upon the death of his predecessor – is apparently in a position of authority over *sedahan* officials, those people, often Balinese, who handle legal disputes about irrigation for the state and who, since Dutch rule, have been tax collectors and who have until recently appointed the heads of subaks. Who gets to be priest is a matter that draws in local and national politics; the 'traditional' power priests will have must be negotiated with several parties (Michael, 1990: 24). Many priests are on record as disagreeing with Green Revolution innovations, but where Lansing sees this as a function of their wisdom, we might also see it as a response to a sense that their authority and position as Brahmans is being jeopardized. Lansing too easily drains 'traditional' Balinese society of differences of purpose both in the past and the present.

A persistent sentiment among high-level bureaucrats to whom Lansing showed the simulation was that it should not be shared with farmers, but rather with the public works department, the agriculture department and the tax people. Since Lansing reports this opinion, he can hardly be oblivious to its political meaning. Nonetheless, when irrigation officials showed up during his filmed meeting with the high priest of the temple of the crater lake, he described it as a realization of his dream of getting the two sides to talk to each other using the simulation as a conversation piece and translation device. He did not portray it as a potentially strategic response of the local representatives of the state (Balinese though they might have been) to the knowledge that a white US American anthropologist was sharing a piece of high technology with local priestly authorities.

We might usefully tie Lansing's optimism to the ideology that grew up around personal computers in the US. The invention of personal computers was heralded by companies like Apple as promoting real participatory democracy: individuals with computers could network and form political action groups, realize their creative potential, and so on. The personal computer was built for the independent individual, free to do as he or she chose (see Pfaffenberger, 1988). I would hazard to say that Lansing's ideas about the democratic possibilities of computer simulations in Bali are driven by these US American ideals (themselves perhaps endorsed by the fact that Apple Computers also gave some support to Lansing's project). What is ignored is the very real issue of how people will get access to digital technologies (not to mention the competencies and legal rights to modify hardware and software) – especially in the context of a world political economy in which development projects are often business deals carefully orchestrated between multinationals and the elites of developing nations. I see little reason to suspect that Lansing's computer simulations will usher in an era of participatory democracy in which Balinese peasants operate in egalitarian dialogue with World Bank officials.¹⁰

Lansing's notion that computer simulations can work as a remedy for social problems also ignores the social and symbolic meanings built into the technology itself; not everyone will approach the simulation with the same sense of what it can tell them. This point was not particularly well recognized in the simulation's earliest conception. During a brainstorming session recorded in Lansing and Kremer's film, one participant expressed the general consensus like this:

Introduction of Mac[is] into Bali is not going to be a problem because [of] the fact that they may not have seen one before . . . but it becomes quite evident what it is and what it does and technology is really quite simple to introduce in most places if it doesn't change people's habits, if it doesn't change their moral and value orientation. If you do that, then it gives them trouble. But if you merely introduce technology it's not going to be a problem . . . (in Lansing, 1991a)

This view is naive. The introduction of such a technology also means the introduction of the economic relations that sustain its production and purchase.¹¹ And the theory of culture articulated here imagines that moral and value orientations can be abstracted from the material worlds that people inhabit. Without a keen sense of the webs of power into which the simulation will be introduced, Lansing's project risks perpetuating and participating in a neocolonialist set of economic relations, a set of relations that keeps Balinese priests and villagers dependent on First World expertise and multinational production regimes and that continues to press them to produce crops for sale on world markets. But while these contexts illustrate the dense nets into which simulations of water temple networks might fall, reading the epistemologies inscribed into the simulations themselves can also give us clues about the colonial heritages that these simulations emerge from and can point us toward some possible neocolonial futures that they may enable.

Computer screens and the colonial gaze

Historian Timothy Mitchell, in *Colonizing Egypt*, writes: 'Colonizing refers not simply to the establishing of a European presence but also to the spread of a political order that inscribes in the social world a new conception of space, new forms of personhood, and new means of manufacturing the experience of the real' (1988: ix). This order is served by control over and responsibility for technologies of representation (censuses, city maps, etc.): 'Such techniques persuade one not that the representation is necessarily exact, but that there is a pure reality out there, untouched by the forms of displacement, intermediation, and repetition that render the image merely an image' (1988: xiii). Mitchell argues that representations can become a powerful tool for surveillance and for the state-supervised reinvention of reality on the model of the representation. Mitchell traces how the distinctively modern epistemology of representation enabled European colonization of Egypt, but his general argument can be extended to other contexts.

The graphics of computer simulations like Lansing and Kremer's are representations that can indeed be used rhetorically to persuade us that the model captures something of 'reality'. The simulation offers the viewer a kind of aerial view or map of a system of irrigation networks. These are panoramic representations that can be used by development officials to capture and rationalize practices like Balinese farming, and as such could become a powerful item in the tool-kit of a scientifically rationalized neocolonialism. The simulation already has programmed into it a set of concerns and perspectives best characterized as those of agricultural officials. It clearly designates certain variables as more important than others. Rice yields, insect populations and rainfall are identified as crucial, while the social and political motives of farmers, unless they can be understood as a form of rational action, are left out. Neither are the machinations of multinationals, USAID and the World Bank figured in. The simulation encodes an objectivist God's eye view, that view most familiar to administrators charged with counting and controlling.

I should emphasize again, however, that Lansing's project, while partaking of and enacting a theory of representation that has well served colonial domination, is in many ways quite different; his project is not part of a mammoth interventionist program and he does not explicitly figure the Balinese as underdeveloped and in need of assistance in production. Nonetheless, Lansing's good intentions are not what is at issue here; it is how his project continues – on a smaller scale, in new combinations – some of the problematic images and practices of neocolonial development.

Simulation and the remapping of nature and culture

While much of my analysis here is critical, I do not think that simulations of social processes must always be tools of domination; it is possible that they might be used in strategies of resistance to development projects – indeed, Lansing and Kremer hope that their simulation can be appropriated as a tool to resist the elimination of water temples that some international development agencies apparently foresee (see Lansing and Kremer, 1994: 221). Simulations describe a world and, like human language, can be instrumental in contests over what will be an authoritative account of reality or a compelling argument about the changing relation between human enterprise and the world in which it unfolds. But simulations will always be used in a grid of power and we forget this at our peril.

Simulations have been used in a wide variety of development projects, and many focus on irrigation in the context of national economies (see Carr and Underhill, 1974; Smith, 1984; Hamza, 1987; various authors, 1988, for a sampling of early work and some critical appraisals). In recent years, researchers at the Santa Fe Institute for the Sciences of Complexity, an interdisciplinary research center in New Mexico and one major hub of

Artificial Life work, have begun computer modeling in the service of 'sustainable agriculture'. This work has been funded in part by Deere, one of the world's largest manufacturers of agricultural equipment. The Institute's vision of how sustainable agriculture simulations will couple with real world practices hints at the extent to which simulations might help remake the world of development agriculture on the model of UN, multinational and elite national interests:

The next generation of combine harvesting machines will be able to play the role of information and data stations, tightly integrated into global agricultural and atmospheric modeling. Data on soil, pest, and crop properties at a given location can be stored and used as input for simulation models that will serve both as input for agricultural planning as well as for global environmental change simulations. (Santa Fe Institute for the Sciences of Complexity, 1993: 18)

In this model, representation and reality are locked in a cybernetic loop, are brought ever closer together, and are made to match on the model and for the purposes of those companies and institutions with the most to gain from 'agricultural planning'.

Computer simulation is an increasingly popular approach among scientists modeling social relations and making policy decisions. Simulations are being used in city planning (see Taylor, 1992a for descriptions), in ecological modeling (see e.g. Holland, 1995), and in understanding world politics and economics (see e.g. Bremer, 1987; Anderson et al., 1988; Epstein and Axtell, 1996). Historian Julian Bleecker (1995) reports that in the wake of the 1992 Los Angeles uprising, social planners began using computer graphics visualization technologies like the RealityEngine™ to imagine possible urban futures. Bleecker has argued that the computer game SimCity2000™, a kind of popular version of the RealityEngine™ in which the player takes the position of a city mayor, critically erases the political category of race. As Bleecker shows, race disappears as a topic of simulation – at the same time that it is always implicitly and perniciously present in the normatively white interpretation of the 'riots' that happen in the game, which are listed along with 'tornadoes' and 'earthquakes' as 'disasters'. Like SimCity2000™, Lansing's simulation leaves out the history of the social terrain with which it is concerned. Missing from Lansing's model of a religio-ecological system that has worked for the last 'one thousand years' is any acknowledgment of the introduction of Indian religion into Bali, of 17th- and 18th-century slavery in the archipelago, of Dutch imperialism, or of Indonesia's struggle for independence. The massacre of more than 80,000 people on the island in 1965 and 1966, in the wake of Suharto's rise to power, is also disappeared, with no acknowledgment of how this may have affected everyday subsistence or been implicated in the retrenchment of urban and rural hierarchies (see Anderson, 1990; Robinson, 1995). Also missing is any sense that 'modern' and 'traditional' have been important terms of contention in nationalist struggle and have shaped the symbolic

and material incorporation of Bali into the national imaginary (see Day, 1986; Vickers, 1996).

The use and abuse of computer simulations bears watching – especially in situations where there is a notable power differential between those putting together the simulation and those whose lives are the subjects and objects of these models. When cultural and natural systems are collapsed into a common language of adaptation and evolution, and when they are modeled using identical methods of computer simulation, we must be careful not to lose sight of the social histories and processes that get washed under in these practices and technologies of representation. Lansing's work is a signal that respect for local and indigenous cultures has begun to shape the way thinking in environmental policy circles is fashioned. But, in its cybernetic collapse of culture into a rationally ordered nature, it is also a warning that conservative, apolitical, visions of social reality can persist even within the most politically and scientifically well-intentioned practices. If Lansing recognizes that cultural enterprise reshapes what counts as landscape and as nature, he only does so by assuming that culture is itself 'natural' (and hence, in this view, rational and rationalizable). Anthropologist Marilyn Strathern diagnoses such a view well in her assessment of the Euro-American sense of nature and culture:

While at one level, a contrast between the natural and the artificial might distinguish different views of culture, it might equally distinguish Culture itself, as intrinsically artificial, from Nature, the source of all that [is] natural. Cultures, in this European view, [are] artificial creations natural to the human condition. (1992: 48)

In geographer Neil Smith's terms, Lansing is operating with two sorts of 'nature', one as a force external to and manipulable by humans and another as a universal category incorporating 'human and nonhuman worlds in endless union' (1996: 39). The abstractions of nature and culture mobilized in Lansing's work and in the sciences of complexity more generally are products of a kind of epistemological double vision, a double vision that often serves to obscure the politics that both enable and overflow it.

Notes

I presented a much earlier version of this argument at the 13th International Congress of Anthropological and Ethnological Sciences, Mexico City, Mexico, 29 July–4 August 1993. Many thanks to Lucía Rayas and Federico Besserer for their translation of my paper into a Spanish language version, 'Simulaciones por Computadora. Neocolonialismo Real: Crítica a los Modelos de Computadora para "el Desarrollo."'. Thanks too to the 1996–7 'Rethinking Nature/Culture' fellows at the Center for Critical Analysis of Contemporary Culture at Rutgers University, where I began to revise this essay into its present form. Colleagues in anthropology and science studies, particularly Thomas Maurer Boellstorff, Marianne de Laet, Ron

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- 1 Lansing writes that 'The Green Revolution began in the laboratories of the International Rice Research Institute in the Philippines in the 1960s and spread swiftly across Asia, gaining a firm foothold in Indonesia by the early 1970s' (1991b: 3). There were many other agencies involved, including USAID, the World Bank and several multinational corporations. The Green Revolution in Bali was supported in the late 1960s by, among others, West German and Japanese multinationals, representatives of the Ford Foundation and the new postcolonial national bureaucracies of Southeast Asia.
- 2 Though Indonesia has greatly increased its rice export due to the Green Revolution, critics would argue that this is not necessarily an index of an improved standard of living for the majority of people.
- 3 The charter for the project of development was written up by the United Nations in 1951. A fragment from this text:

There is a sense in which rapid economic progress is impossible without painful adjustments. Ancient philosophies have to be scrapped; old social institutions have to disintegrate; bonds of caste, creed and race have to be burst; and large numbers of persons who cannot keep up with progress have to have their expectations of a comfortable life frustrated. Very few communities are willing to pay the full price of economic progress. (United Nations, Department of Social and Economic Affairs, 1951: 15, quoted in Escobar, 1995: 4)

It is this ethnocentric and ethnocidal project to which Lansing sees his work as a corrective.

- 4 Historian of science Donna Haraway points out that the separation of 'modern' and 'traditional' often rests on a view of human social reality which marks some people as 'closer to nature' than others (1991: 314). The image with which I began this article – the Balinese priest using the Macintosh computer – is delivered by the film-makers as a kind of entertaining contradiction for audiences for whom the categories 'traditional' and 'modern' have practical and political implications (with 'modern' being the privileged of the pair in the folk wisdom of 'development,' for example). Haraway might argue – as she has for similar images – that we can read this picture as:

... a touch across time and space, and across politics and history, to tell a story of salvation, of saving man and nature. In this version of cyborg narrative, the touch that joins portable high technology and 'primitive' human parallels the touch that joins animal and 'civilized' human. (1991: 335, note 28)

- 5 Adrian Vickers (1996) points out that this view, promoted in the mainstream anthropology of Bali (exemplified by Mead, Bateson and Geertz), ignores the ways 'tradition' has actually been an important ingredient in Indonesian and Balinese articulations of the 'modern'; to be '*modern*' (the Dutch term taken on by early nationalists) is to participate in an indigenous modernity that requires the mobilization of ethnic and national identity in the service of and as a resource for 'change' and 'progress'.
- 6 Lansing maintains that there are similarities between Balinese and 'scientific'

conceptions of time: '... in science, as distinct from social science ... time measures the duration and analysis of periodicity' (1991b: 161, note 27).

- 7 Self-organization is a process that can occur in both natural and artificial systems, but Lansing's use of this term in conjunction with 'spontaneous' erases the very human intentionalities he is concerned to retrieve, collapsing them into the 'nature' that they are supposed to be shaping. Thanks to mathematician and historian Ron Eglash for this insight.
- 8 Anthropologist Arturo Escobar writes of how the project of 'integrated rural development', which was 'conceived by experts as a strategy to correct the biases of the green revolution' by focusing on the entrepreneurial 'needs' of small farmers, continued to value production for a market as the key goal for development (1995: 155). Lansing's project might well be seen as a permutation of this sort of project.
- 9 The simulation was available in Indonesian, Balinese, and English. Lansing and Kremer showed it first to irrigation officials (in Indonesian) in the Balinese capital.
- 10 A.J. Michael writes that 'One of the major points that has surfaced in the primary studies of the Green Revolution is that the peasants are viewed as objects in a great plan of modernization' (1990: 9). Michael cites anthropologist Luisa Para, who conducted research in the state of Puebla, Mexico on the effects of the UNRISD Global Two Project: 'Cultivators felt that they were the objects rather than the subjects of the plan. ... They had little voice in the planning of the campaigns, in field trials and in evaluation of the results of the package' (Michael, 1990: 9, note 13). I would argue that Lansing's model itself – quite apart from the political context in which it may be used and co-opted – does little to empower Balinese farmers since it imagines them as operating with a deterministic rationality, anyway.
- 11 In the film, Lansing argues that while Maes may be expensive for Balinese village organizations, they are cheaper ways of managing irrigation than costly and often ineffective dam construction. But just because computers are smaller and individually cheaper than dams does not mean that they will not bring with them a complex of political economic relations and dependencies. We might speculate on just who puts together some of these computers. The nearby Philippines is a well known off-shore production site. Indonesia, the Philippines, and the multinational university-industrial complex could become implicated in an intricate web of economic relations, indeed.

References

- Anderson, Benedict (1990) *Language and Power: Exploring Political Cultures in Indonesia*. Ithaca, NY: Cornell University Press.
- Anderson, Philip, Kenneth Arrow and David Pines, eds (1988) *The Economy as an Evolving Complex System*. Redwood City, CA: Addison-Wesley.
- Bleecker, Julian (1995) 'Urban Crisis: Past, Present, and Virtual', *Sociologist Review* 24(1/2): 189–221.
- Bremer, Stuart, ed. (1987) *The Globus Model: Computer Simulations of Worldwide Political and Economic Developments*. Frankfurt am Main: Langus Verlag.
- Carr, D.P. and H.W. Underhill (1974) *Simulation Methods in Water Development*. Rome: Food and Agriculture Organization of the United Nations.

- Day, A.J. (1986) 'How Modern was Modernity, How Traditional Tradition, in Nineteenth-Century Java?', *RIMA* 20(1): 1-29.
- Eglash, Ron (1997) 'When Math Worlds Collide: Intention and Invention in Ethnomathematics', *Science, Technology and Human Values* 22(1): 79-97.
- Epstein, Joshua and Robert Axtell (1996) *Growing Artificial Societies: Social Science from the Bottom Up*. Cambridge, MA: MIT Press.
- Escobar, Arturo (1995) *Encountering Development: The Making and Unmaking of the Third World*. Princeton, NJ: Princeton University Press.
- Feder, Ernest (1983) *Perverse Development*. Quezon City, Philippines: Foundation for Nationalist Studies.
- Ferguson, James (1990) *The Anti-Politics Machine: 'Development', Depoliticization, and Bureaucratic Power in Lesotho*. Cambridge: Cambridge University Press.
- Geertz, Clifford (1963) *Agricultural Involution: The Process of Ecological Change in Indonesia*. Berkeley: University of California Press.
- Gessler, Nicholas (1994) 'Artificial Culture', in Rodney A. Brooks and Patric Maes (eds) *Artificial Life IV*. Cambridge: MIT Press/Bradford Books.
- Gibbons, David S., Rodolphe de Koninck and Ibrahim Hasan (1980) *Agricultural Modernization, Poverty, and Inequality: The Distributional Impact of the Green Revolution in Regions of Malaysia and Indonesia*. Westmead, England: Gower Publishing Company, Ltd.
- Glaeser, Bernhard (1987) *The Green Revolution Revisited: Critiques and Alternatives*. Boston: Allen and Unwin.
- Gunneman, George J. and Murray Gell-Mann, eds (1994) *Understanding Complexity in the Prehistoric Southwest*. Redwood City, CA: Addison-Wesley.
- Gupta, Akhil (1992) 'The Reincarnation of Souls and the Rebirth of Commodities: Representations of Time in "East" and "West"', *Cultural Critique* Fall: 187-211.
- Gupta, Akhil (1998) *Postcolonial Developments: Agriculture in the Making of Modern India*. Durham, NC: Duke University Press.
- Hamza, M.H., ed. (1987) *IASTED International Symposium: Simulation, Modeling, and Development*. Anaheim, CA: Calgary Press.
- Haraway, Donna (1991) 'The Promises of Monsters: A Regenerative Politics for Inappropriate/d Others', in Lawrence Grossberg, Cary Nelson and Paula Treichler (eds) *Cultural Studies*, pp. 295-337. New York: Routledge.
- Holland, John (1995) *Hidden Order: How Adaptation Builds Complexity*. Redwood City, CA: Addison-Wesley.
- Lansing, J. Stephen (1991a) *The Goddess and the Computer*. Watertown, MA: Documentary Education Resources (60-minute video).
- Lansing, J. Stephen (1991b) *Priests and Programmers: Technologies of Power in the Enginerated Landscape of Bali*. Princeton, NJ: Princeton University Press.
- Lansing, J. Stephen (1992) 'The Gods of the Countryside: Emergent Properties of Balinese Water Temple Networks', paper presented at Artificial Life III, Santa Fe, NM, 15-19 June.
- Lansing, J. Stephen (1995) *The Balinese*. Fort Worth, TX: Harcourt Brace College Publishers.
- Lansing, J. Stephen and James N. Kremer (1993) 'Emergent Properties of Balinese Water Temple Networks: Coadaptation on a Rugged Fitness Landscape', *American Anthropologist* 95(1): 97-114.
- Lansing, J. Stephen and James N. Kremer (1994) 'Emergent Properties of Balinese Water Temple Networks: Coadaptation on a Rugged Fitness Landscape', in Christopher Langton (ed.) *Artificial Life III*, pp. 201-23. Redwood City, CA: Addison-Wesley.

- Michael, A.J. (1990) 'The "Green Revolution" and Traditional Systems of Agriculture and Irrigation in Bali', Stanford, CA: Stanford Center for Conflict and Negotiation.
- Mitchell, Timothy (1988) *Colonizing Egypt*. Berkeley: University of California Press.
- Pfaffenberger, Bryan (1988) 'The Social Meaning of the Personal Computer: Or, Why the Personal Computer Revolution Was No Revolution', *Anthropological Quarterly* 61(1): 39-47.
- Rappaport, Roy (1967) *Pigs for the Ancestors*. New Haven, CT: Yale University Press.
- Rappaport, Roy (1971) 'The Sacred in Human Evolution', *Annual Review of Ecology and Systematics* 2: 23-44.
- Robinson, Geoffrey (1995) *The Dark Side of Paradise: Political Violence in Bali*. Ithaca, NY: Cornell University Press.
- Santa Fe Institute for the Sciences of Complexity (1993) *1992 Annual Report on Scientific Programs*. Santa Fe, NM: SFI.
- Shiva, Vandana (1991) *The Violence of the Green Revolution: Third World Agriculture, Ecology and Politics*. London: Zed Books.
- Smith, Eric A. (1984) 'Anthropology, Evolutionary Theory and the Explanatory Limits of the Ecosystem Concept', in Emilio Moran (ed.) *The Ecosystem Concept in Anthropology*, pp. 51-86. Boulder, CO: Westview Press.
- Smith, Neil (1996) 'The Production of Nature', in George Robertson, Melinda Mash, Lisa Tucker, Jon Bird, Barry Curtis and Tim Putnam (eds) *Future/Nature: Nature, Science, Culture*, pp. 35-54. London: Routledge.
- Strathern, Marilyn (1992) *Reproducing the Future: Anthropology, Kinship, and the New Reproductive Technologies*. New York: Routledge.
- Tainter, Joseph A. and Bonnie Bagley Tainter, eds (1996) *Evolving Complexity and Environmental Risk in the Prehistoric Southwest*. Redwood City, CA: Addison-Wesley.
- Taylor, Charles (1992a) 'Fleshing Out' Artificial Life II', in Christopher Langton, Charles Taylor, Doyme Farmer and Steen Rasmussen (eds) *Artificial Life II*, pp. 25-38. Redwood City, CA: Addison-Wesley.
- Taylor, Charles (1992b) 'Artificial Life to Study Ecology and Population Biology', paper delivered at Artificial Life III, 15-19 June, Santa Fe, New Mexico.
- Vickers, Adrian (1996) 'Modernity and Being "Modern": An Introduction', in Adrian Vickers (ed.) *Being Modern in Bali: Image and Change*, pp. 1-37. Monograph 43, Yale Southeast Asia Studies. New Haven, CT: Yale University Southeast Asia Studies.
- various authors (1988) *International Symposium on Systems Analysis Applied to Management of Water Resources, Rabat, Morocco*. New York: Oxford University Press.

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