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Nature and the Spirit: Ritual, Environment, and the *Subak* in Bali

Hao Huang¹

The objective of the Envirolab Asia Faculty Lab project in Bali was to learn onsite about the Balinese *subak* water temple system, as a case study of how indigenous agricultural and sacred practices address environmental stewardship. As a scholar of color, I am motivated to find ways to change how “developed” societies perceive “less advanced” cultures. This article begins with an exploration of the religious and cultural significance of the Balinese goddesses of rice and water, Dewi Sri and Dewi Danu. Subsequently, “the sacredness of water and the holiness of height” in Balinese cosmography is discussed. Next, principles that guide *Subak* activities are explored, which leads to a survey and explanation of *Subak* ritual practices. The heart of the essay focuses on “why *Subak* matters,” followed by an examination of “the *Subak* in jeopardy” during the “Green Revolution.” An investigation of “the Return of the *Subak*” ensues, followed by a consideration of the future of *Subak*.

I urge fellow Western academics to be skeptical of the notion that new technological knowledge is inherently more effective or practical than the old. This is particularly apropos now, as *Subak*’s historically integral role in Balinese culture in connecting rice farmers and village communities with water temple collective irrigation decision-making and procedures is clearly weakening. Balinese rice agriculture in the *Subaks* is presently jeopardized by “modern” neoliberal government policies, water shortages caused by mass tourism, the transition to a cash economy, and drastic changes in cultural paradigms. Will the *Subak* survive?

Let us speak of the spirits of rice and water...

Bali is fabled for its lustrous verdant loveliness, as it floats in a brilliant azure sea. This is due in no small part to how Balinese farmers have carved the landscape over millennia into jewel-like facets of *ladang padi* (rice fields, from which we derive the term rice paddy). Viewed from afar, the rice terraces glow with green plantings and shimmering watery surfaces, following the contours of the land from mountain craters to the ocean. These rice terraces perpetuate technology that is over a thousand years old,² that has produced sophisticated systems of engineering designed around slope angles, gravity powered hydrology and nutrient cycling. Life on Bali has depended upon how well water irrigation for rice fields has worked for more than a millenium. Rice, and the water needed to sustain it are not only essential necessities of earthly life on Bali, they are fundamental elements in Balinese religion. Accordingly, the Balinese

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² Jan Wisseman Christie, “Water and rice in early Java and Bali” in *A World of Water: Rain, Rivers and Seas in Southeast Asian Histories*, ed. Peter Boomgaard (Leiden: Brill, 2007), 250.

worship the rice goddess *Dewi Sri*, and *Dewi Danu*, goddess of water in the life-giving lakes and rivers of the island. Every temple prayer ends with a sprinkle of *tirta*, (holy water), on the heads and hands of the *pemaksan* (congregation of worshippers). During a Galungan house ceremony, a Balinese priest anointed Joti, me and other attendees with *Wija*, rice grains consecrated with holy water, placed on the forehead (for wisdom), throat (for happiness) and given to be put in the mouth (for prosperity).

Everywhere we went in Bali, we saw religious ceremonies practiced daily, composed of myriad rituals to propitiate ancestral spirits and deities of water, fire, earth and sun, of the mountains and the sea, of gods and demons. These form the core of the Balinese sacred practices, usually described as Hinduism, but what we experienced “on the ground” (and often very literally on the ground, stepping on and over votive offerings in the streets) during our Envirolab Asia faculty lab fieldwork was too local, too animistic, to be closely identified with orthodox Brahmanic-Sanskritic Hinduism. Our experiences suggested that Balinese Hinduism is a hybrid religion that integrates Indian Hinduism with indigenous animist beliefs. In fact, Ramstedt (2013) has noted that Balinese traditionalist ritualism is informed by pre-Hindu ancestor worship and is the fundamental basis of local customary law.³

Fieldwork observations of various Balinese sacred rites lead us to believe that Hinduism has overlaid indigenous religious practices, adding to but not substituting for deep-rooted animistic beliefs of Balinese. Most Balinese continue to venerate local agricultural, water and earth deities that must be constantly propitiated to guard against misfortune. Consider for example the ubiquitous *saput polèng* (the black and white checkered pattern cloth), used in clothing for humans and also used for non-human entities, draped over trees, rocks, sculptures, columns and other sacred objects. This textile relates to the *Rwa Bhinedam*, a Balinese philosophy of balance and harmony between opposites as represented in the alternating black and white squares. When an object is wrapped in this material, this indicates that a spirit resides within. The cloth enfolds the spirit and its energy while protecting people from being disturbed by the spirit. Such a case speaks more to indigenous animism than Hindu doctrine.

Evidence of rice cultivation on Bali has been dated by archaeologists to more than two thousand years ago.⁴ Not only is rice the staple food in the Balinese diet, it plays a central cultural, historic and religious role. The colors of the three kinds of native Balinese rice have a special sacred significance:

1. *Ketan*: white sticky, glutinous rice that is used for daily religious offerings in Bali and traditionally brings good luck. This rice was the most common grain and was the everyday staple food in Bali until the “Green Revolution miracle rice” displaced it.
2. *Injin*: black rice (actually a dark, blackberry purple) was the second most common grain as it yielded less than *Ketan*, and turns to black only at the time of harvest. Black glutinous rice is black on the outside but white inside and is used to make desserts.
3. *Barak*: “red” rice, the rarest and the most expensive rice produced in Bali (in reality pink rather than red in color). It is usually reserved for special temple offerings.

³ M. Ramstedt, “Religion and Disputes in Bali’s New Village Jurisdictions” in *Religion in Disputes: Pervasiveness of Religious Normativity in Disputing Processes*, ed. Franz von Benda-Beckmann, Keebet von Benda-Beckmann, Martin Ramstedt, and Bertram Turner. (New York: Palgrave Macmillan, 2013), 119.

⁴ Bellwood et al, “New dates for prehistoric Asian rice”, in *Asian Perspectives* 31 (1992), 166.

Colors hold deep symbolic meanings in the Balinese holy trinity concept of *Trimurti*: each of the main three deities is identified by a color: Red symbolizes *Brahma*, the god who created the universe. White is for *Wisnu/Vishnu*, the protector. Black symbolizes *Siwa/Shiva*, the destroyer. It is curious that these colors correspond with the three color categories of Balinese rice! Concomitantly, the same sacred colors are associated with three of the four sacred cardinal points in Bali: South - red; East – white; North – black. West is identified with the color yellow. Where is the missing yellow rice? A well-known Balinese legend speaks to this issue. The gods had intended to give the Balinese rice of all the sacred colors. *Siwa* sent a bird to deliver all the rice to the Balinese people, but the bird ate most of the yellow rice in transit, leaving only a small residue. The bird then planted the remaining yellow rice under the eaves of its home and the grains grew into *Kunyit*, turmeric. This explains why the yellow rice variety is not found in Bali; however, Balinese have learned to make yellow rice by mixing white rice with turmeric! Intriguingly, this yellow rice is used during specific festivals, especially during *Kuningan*, when *Pitru Paksha*, pre-Hindu Balinese ancestor worship, is practiced in the present.⁵

As in many Southeast Asian countries, Balinese traditional belief holds that a goddess gave rice to humans and taught them how to grow it.⁶ Rice thrives in *Pulau Dewata*, the Island of the Gods, as the gift of the goddess *Dewi Sri*, whose likeness we found all over the island, in restaurants, homes and rice fields. The Balinese language has many words for rice: *nasi* (which also denotes “meal”); *padi* (rice on the stalk growing in the field -- the English word “paddy” comes from *padi*); *gabah* (unmilled rice that has been separated from the stems), and *beras* or *baas* (milled, uncooked rice).

We were repeatedly told by Balinese that the rice plant is a sacred symbol, a manifestation of *Dewi Sri*. To mark significant occasions during the rice cultivation cycle, dozens of little rice stalk figures of *Dewi Sri* are made in the form of two triangles with points touching, called a *Cili*. During harvest time a sacred image of *Dewi Sri* is constructed from rice at the corner of the rice field where irrigated water enters. This rice statue is then carried to the rice “barn,” *lumbung*, a raised storehouse built off the ground on posts to deter vermin, that stores rice and rice related materials near the kitchen.⁷ There daily offerings are made to *Dewi Sri*, who is not only the goddess of fertility and the protector of the rice fields, but also guardian of the rice “barn.” As the EnviroLab Asia study group traveled around the island, we had many opportunities to notice the spiritual dimensions to the growth, preparation and consumption of rice in Bali. This is most evident in the myriad rice field shrines where a daily routine of prayers and offerings are rendered to the life-giving rice goddess, *Dewi Sri*. Rice farmers maintain an annual cycle of ceremonies that celebrate the water opening (field flooding), rice field preparation, rice transplanting, growth, first appearance, flowering, and harvesting. We saw priests place rice on worshipper’s foreheads, in similar fashion to a bindi (the colored dot worn on the forehead by

⁵ *Kuningan* is the day when Balinese ancestors ascend to heaven after visiting the earth during the *Galungan* festival day, that celebrates the victory of good (Dharma) over evil (Adharma). The offerings given to the ancestors on their farewell day include yellow rice (*Kuningan* is derived from the word *kuning*: yellow). The yellow rice stands as the symbol of human beings’ gratitude to their ancestors for the blessings of life, joy, health and prosperity. Festive *nasi kuning* is served in a decorative, mountain-peak shaped cone crowned with a banana leaf cap, both to please and to represent the ancestral gods (who reside at the summit of Bali’s most sacred mountain, *Gunung Agung*).

⁶ S.C. Ahuja and Uma Ahuja, “Rice in Social and Cultural Life of People” in *Rice Origin, Antiquity and History*, Ed. S. D. Sharma. (Boca Raton: CRC Press, 2010), 42.

⁷ V. Kruger, *Balinese Food: The Traditional Cuisine & Food Culture of Bali*. (Rutland, VT: Tuttle, 2014), 105.

Hindus representing the third eye), to confirm that these people have already given thanks to *Dewi Sri* that day.

The growth of all living things is governed by the female deities *Pretiwī*, the earth goddess, *Sri*, the rice goddess, and *Dewi Danu*, the goddess of waters. To support all the rice fields in Bali, even a peripatetic rice goddess needs collaborators! The water goddess *Dewi Danu* rules over the crater lake on the second-highest peak in Bali, Mount Batur (occasionally identified as the cosmic mountain Mt. Meru). The Goddess resides in her temple, called *Pura Ulun Danu Batur*, also known as the Temple of the Crater Lake. The goddess “is believed to be responsible for the gift of the waters that irrigate their fields;” therefore farmers believe that “those who do not follow her laws may not possess her rice terraces.”⁸

The caldera Lake Batur, the holiest of all four caldera lakes in Bali, is worshipped as the ultimate source of water for all the rivers and springs of Bali, with its temple consequently the most sacred and most important of all the water temples. Accordingly, the *Ulun Danu Batur* temple is blessed with several qualities: it is the paramount water temple, located at the sacred summit of the cosmic mountain Mount Agung/Mount Meru; it is the unique source of the holiest sacred water and is the only temple where the priesthood is selected by the gods themselves. These divine attributes combine give *Pura Ulun Danu Batur* a mystical ambience, particularly on the days when its most cherished treasure, a gamelan salunding (the most ancient metallophone made from iron) rings out resonant tones as flowers carpet the temple’s vast courtyards, floral offerings left by thousands of worshippers. It is then, as J.S. Lansing writes, that “it is not difficult to believe, as a priest once told me, that if you look hard at the air over the crater lake, gods may appear.”⁹

The sacredness of water and the holiness of height

Traditional Balinese religion is commonly referred to as “*agama tirtha*, the religion of holy water.” There are many terms for water in Bali that correspond to how it is being used, whether for everyday consumption (*yeh*) or healing (*amerta*), with *tirtha* (holy water) being the most prized. *Tirtha* is essential to ritual purification and is required for ritual removal of pollution. Water is not limited to performing a role in religious life-cycle and cleansing rituals; the flow of agricultural water from the relatively pure highlands to the impure lowlands affirms the natural hierarchy of high to low. Lansing explains that “water is revered for its power to make things grow, and to wash away impurities both physical and spiritual”.¹⁰ This bimodality gives water an intrinsic value, as well as utilitarian merit.

In Bali, myriad sacred springs are incorporated into a sophisticated water distribution system rooted in the island’s water temples, called *pura subak* or *pura ulun swi*. During coordinated temple ceremonies water is blessed. From the water temple at the summit, *Ulun Danu Batur*, the blessed water is carried down to lower water temples following the hierarchical order, gathering the blessings of local deities along the way. Every temple affirms in the receiving and joining of sacred waters the hierarchical system of water temples and their congregations. This movement

⁸ J. S. Lansing, “Balinese ‘Water Temples’ and the Management of Irrigation” in *American Anthropologist*, 89:2 (1987), 330, 338.

⁹ J.S. Lansing, *Perfect Order: Recognizing Complexity in Bali*. (Princeton University Press, 2006), 156.

¹⁰ Lansing 1987, 330.

of blessed waters accompanied by prayer and incantation proceeds down to the *Subak*, *Munduk* and individual farm-field level. Thus, a connection between religion and agricultural production is established by the *Subaks*, those organizational systems that regulate irrigation and agricultural functions to maintain ecological productivity. Hauser-Schaeublin asserts that water in Bali is not “open access” but a “gift of the gods.”¹¹ This concept empowers the priests and members of *Subaks*, who are believed to be blessed by the gods, to legitimately exercise control over water management.

We visited the magnificent water temples on Lakes Bratan and Batur, from which irrigation water slowly courses down from the mountains to the ocean, via canals leading to head-of-terraces temples and later to head of fields temples, irrigating rice fields on its journey down the slopes. The *Subak* system embodies a literal and metaphorical hierarchy. In Bali, purity and sacredness correspond to height – for example, for human beings the head is purer than the unclean lower body—similarly, the water temples at the highest elevations in the landscape are at the top of the hierarchy, channeling pure water to lesser temples downstream that distribute water to the rice fields, from which the water ultimately flows into impure waters at sea level. The water temples perched on volcanic summits, *Pura Ulun Danu Batur* and *Pura Ulun Danu Bratan*, form a divine symmetry with the coastal temples, *Pura Masceti* and *Pura Beji*. The “high” temples mark the pure, sacred volcanic lake origins of Bali's freshwater resources, while the “low” temples show where rivers enter the chaotic, impure domain of the ocean. A plethora of lesser water temples fill the space between these two axis.¹²

Traditionally, Balinese conceptualize their landscape on three planes: mountains, lowlands and beaches. These levels correspond with Balinese sacred values: *utama*/sacred, *madya*/middle, and *nista*/profane. Mountains hold paramount sacred value, as a source of life, where the people have access to pure water. The lowland valleys have social value, as places where people live and interact with each other in daily activities. The beaches are considered the profane value, contaminated by effluent running off into the sea. This is how, as Clifford Geertz has suggested, “a complex ecological order is both reflected in, and shaped by, an equally complex, local ritual order, which at once grow out of it and is imposed upon it.”¹³

Hierarchies of height are complicated by the religious principles of *Purusa* and *Pradana*. The numinous realm of higher elevation is identified with *Purusa*, the atmosphere or the ether. The base earthly elements correspond to *Pradana*.¹⁴ For Balinese, successfully negotiating interactions between *Purusa* and *Pradana* leads to a balance in life which is *Santhi* (peaceful in

¹¹ B. Hauser-Schäublin. “Land Donations and the Gift of Water. On Temple Landlordism and Irrigation Agriculture in Pre-Colonial Bali” in *Human Ecology* 39:1 (2011), 45.

¹² The flow of water from sacred lakes to rice terraces is mediated by an elaborate system of man-made canals and dams. Small water temples are located at each dam site, enclosing shrines where supplicants make daily offerings. In addition, each rice paddy contains a tiny shrine where the irrigation water first enters the field. Collectively, the water temples make up a nested hierarchy of religious sites that unify the rice fields within entire terraced hillsides that are watered by a single source. In such a way, the landscape ecology is linked to the social production of rice and to the hierarchical order of the Balinese cosmos. As Lorenzen's (2015) article on the “future of Balinese irrigated rice societies” indicates, the subak system goes beyond treating water as mere resource or commodity, but exemplifies how water is implicated within a religious framework.

¹³ C. Geertz, *Negara: The Theatre State in 19th Century Bali* (Princeton University Press 1981), 82.

¹⁴ N. Dwijendra, *Arsitektur rumah tradisional Bali: berdasarkan asta kosala-kosali* (Udayana University Press 2008), 67.

spiritual and physical happiness). The concept of *Ardhanarishvara* symbolizes the generative power of male and female principles that cannot be separated, half *Purusa* and half *Pradana*. The unification of *Purusa* and *Pradana* is essential to producing the *bayu* (energy) necessary to produce the various living beings in this world.

Intriguingly, Lansing suggests that the rituals of water temples reflect and embody the feminine logic of *pradana*.¹⁵ Men set aside their caste differences in order to reconfigure themselves as members of a unified social group, the *Subak*, to join together to promote the fertility of their crops and harmonious order in the local community. Caste is identified with *Purusa* as lineage from male ancestor-gods. Conversely, water temple rites follow the path of *Pradana*, where the problem of supporting fertility and growth is resolved by properly aligning material elements. This depends on the cooperation of all farmers within their community, arrived at through a process of democratic consensus. An inability to work together because of differences of social status or individual self-interest will lead to bad consequences for all. Water temples offer a formal space for farmers to convene in open assembly and celebrate communal gratitude to the gods. In this context, water temple priests are essential spiritual and social community leaders who can negotiate directly with agricultural deities on behalf of other Balinese. But even more importantly, temple rituals provide opportunities to practice communal cooperation needed for the proper operation of the physical irrigation systems.

Geertz has proposed that Balinese ecology takes an “active, central and creative” role in shaping Balinese life and that water plays a central role.¹⁶ The hierarchical system of water temples ensures that primary decisions about water management are made at key geographic locations. The networks of water temples aim to sustain a harmonious relationship with the natural and spiritual world through an intricate series of rituals, offerings and artistic performances. Regular rituals accompany the water with blessings and offerings from the head of the watershed, down to the lowlying rice fields. In a conversation we had with a *Subak* member in the Ubud area in summer 2019, Nyoman Astana described how villagers conscientiously make daily religious offerings to ward off the devastating agricultural repercussions of gods becoming angry: drought, pests, fire. These daily practices maintain the life-assuring balance between the seen and unseen forces that inhabit the Balinese cosmos. If this balance is disturbed, misfortune, sickness, and death will follow. Thus, balance must be regularly protected and renewed through constant observance of rules for proper behavior and traditional ritual activity.

Subak principles

No consensus exists for a categorical definition of the term *Subak*. Raka defines *Subak* as a rice-field unit irrigated from a river or a single dam or canals along the river.¹⁷ Still others define *subak* as a collective of farmers within an irrigation district congregated around a Balinese water temple, that sacred place where people can commune with and give thanks to the *Dewi Danu* and other ostensibly Hindu but clearly animist deities. Sutowan proposes that the word “*Subak*” has multiple meanings: as an irrigation network or irrigation system; as the group of paddy farmers who are members of the irrigation association; and as the rice fields (*sawah*) belonging to the

¹⁵ Lansing 2006, 210.

¹⁶ Clifford Geertz, “The Wet and the Dry: Traditional Irrigation in Bali and Morocco” in *Human Ecology* 1:1 (Mar 1972), 192.

¹⁷ I.G.G. Raka, 1955 *Monographi Pulau Bali*. (Djakarta: Ministry of Agriculture, 1957)

designated group.¹⁸ The fecundity of these irrigated rice paddies depends on the regular flow of water through an elaborate irrigation system organized by these watershed societies, agreed upon and maintained by all *Subak* members.

Our conversations in Bali with *Subak* members lead us to believe that Balinese *subaks* are physical and human networks that link to irrigated *sawah* (rice field) networks. These *subaks* are all interlinked organizationally, spiritually, economically and infrastructurally through island-wide irrigation and the environmental networks.¹⁹ Each *subak*, as a network of inter-related *sawahs*, is interlinked with other *subaks* of the same watershed. Together, networks form larger, more complex, inter-related systems that require cooperation and reciprocity. This creates links between the socio-economic, physical, environmental, cultural, spiritual, community, village and family features of Balinese life. This principle of interlocking patterns also characterizes Balinese gamelan music.

Farmers take turns growing rice in a ritualized cycle that coordinates with not one, but two calendars: *Uku*, a 210-day calendar that consists of thirty weeks, which correlates to the growth cycle of *Padi Bali*, Balinese rice; and the Indian lunar-solar calendar *Icaka*, that represents a later, separate system (introduced with Indian Hinduism). During dry season, water supply is managed on a rotational basis called the *pergiliran* or *nyorog* system. The principle of *nyorog* involves the upstream fields getting water first (*ngulu*); next midstream farmers draw water after upstream soil has been cultivated (*maongin*); and last the downstream rice paddies get access to water (*ngasep*). During the rainy season, rice planting is simultaneously done everywhere in the *Subak* (*kertamasa*), since mass volume water storage is not part of the *subak* infrastructure, as the island's volcanic soil is porous. Additionally, the *Subak* system promotes region-wide fallow periods (with regards to wet rice cultivation) to control insect and rat populations, as well as crop diseases. During those "dry" fallow periods, farmers often grow other crops that thrive on heat and require less water, such as peanuts, soya beans, chili peppers, tapioca and corn. This describes how *Subak* members adapt to the changing conditions of their ecosystem. Sustaining the *Subak* system in Bali requires a consensus on socio-cultural values. Decisions about water use and cropping patterns can pose an ethical dilemma: self-interest dictates that each farmer will withdraw as much water as possible to maximize their own rice yields, but unrestricted water use by upstream farmers will result in water scarcity for their downstream fellows. It is only through coordinating periods of flood and fallow over an extensive area that farmers can eliminate food and habitat for pests; this requires tactical water sharing so that planting will be done simultaneously both upstream and downstream. Cooperation and coordination are necessary to reconcile individual water demands with strategic use of irrigation to prevent pests from spreading.²⁰

¹⁸ N. Sutawan, "Tri Hita Karana and Subak - In Search for Alternative Concept of Sustainable Irrigated Rice Culture," *Udayana University: Indonesia International Network for Water and Ecosystem in Paddy Fields INWEPF/SYMPOSIUM/2004(04)*, 1.

¹⁹ The water temples enact Balinese cosmological principles, whereby *kaja* (upstream or mountain) is associated with purity and the celestial, while *kelod* (downstream or sea) is linked to the dangerous underworld. Regional systems of water temples preside over the paths etched in the mountainside by the waters of the goddess *Dewi Danu*, flowing down the countryside as they simultaneously nurture growth and bear away pollution.

²⁰ Brooks, J., Reyes-García, V. & Burnside, W., "Re-examining balinese subaks through the lens of cultural multilevel selection" in *Sustainability Science* 13:35 (2018), 40-41.

Subak practices involve maintaining traditional ecologically sustainable irrigation systems and following water management plans that help to conjoin Balinese agricultural communities: from rice fields, to village, to Balinese water temples. The *Subak*'s mission is to manage equitable water distribution to ensure bountiful staple food production, especially rice. The operation and maintenance of the irrigation infrastructures have been carried out over many centuries on a basis of mutual help with little outside support. Irrigation is coordinated with calendrical cycles, marked by ritual ceremonies performed at watershed temples. Such a system demands intensive labor, accurate regulation of water supplies and maintenance of proprietary dikes, canals, fields and terraces. It requires general agreement within a community. Under these circumstances, well-organized social groups develop, both as cause and effect.

Subak ritual practices

Religious rituals closely linked to stages of rice cultivation regularly occupy *subak* members. In fact, some Balinese confided to us that the burden of ceremonial obligations sometimes felt quite taxing. For most rice farmers in Bali, the most important responsibility of the *subaks* is to accurately and collectively perform calendrical rites in water temples. These rites clearly have functional significance, by encouraging farmers' awareness of their shared dependence. *Subak* rituals (often remarkably similar to human rites of passage) are regularly discharged alongside rice farming activities starting from field preparation, heralded by a "water opening ceremony"; seeding; transplanting; rice plant flowering; harvesting and stocking rice in the granary. Each growing season is marked by four major *Subak* ceremonies: (1) *pelemekIngelemek*, observed after wet rice is planted to assure healthy growth; (2) *nyeeb*, conducted after weeding is completed; (3) *ngatunin*, the foremost ceremony, carried out when the wet rice begins to flower, requiring a pig sacrifice to consecrate the rice field; and (4) *biyukukung*, celebrated after the harvest.

Subak rituals range from worship by individual farmers at their personal altar to joint ceremonies with fellow members of the same *Subak* or even from other *subaks*. These rituals provide constant reinforcement of the religious creed that water is a gift from God(s) that must be used equitably for the benefits of the many, not just the few. Chroniclers suggest that the community endeavor of sustaining these religious rituals has brought harmony and social stability to many rural areas in Bali. The highly ritualized nature of *Subak* has helped Balinese rice farmers resolve social problems associated with managing shared resources and coordinating cropping patterns. This is the why *Subak* is often defined as a socio-religious irrigation institution, differentiating it from most of other irrigation systems in the world.

The *Raja Purana Pura Ulun Batur*, the sacred "handbook" for performing rituals at the ascendant water temple in the caldera of Batur Volcano, prescribes in detail how the rites required to conjoin *Dewi Danu* and ancestral spirits to the living must be performed, thereby ensuring human well-being.²¹ Any violation of protocol will not only offend the deities and ancestral beings, but will also be punished by the *Subak* leadership. There are principally three categories as to support for ritual performances: simple, medium, and elaborate. These gradations conform to another tripartite cosmological principle, called *tri angga* with regards to the three parts of the human body (legs, torso, and head), and *tri loka* when applied to the rank

²¹ P. Budiastara, *Rajapurana Pura Ulun Danu Batur, Kintamani, Bangli, Vol. 2* (Denpasar: Museum Bali, 1979)

order of the world of the gods, the world of men and the world of lower nature spirits and demons.²²

Many informants described the relationship between man and nature as akin to that of a fetus in the womb. Injuring the womb will assuredly harm the fetus itself. This simile implies that people must care for the natural environment so that it can foster human life for generations to come. Furthermore, most Balinese village societies develop relationships with the environment that are influenced by both emotional and cultural connections to place.²³ⁱ Krause (1988) states that villages often manage their lands based on perspectives of life in the natural world. Traditional Balinese villages operate with the belief that land does not belong to individual human beings: “the earth belongs to the Gods”. *Wong desa angertanin gumin Ida Betara* is a widespread traditional Balinese saying that human beings only manage the land, but the land is possessed by the divinities.²⁴

Why Subak Matters

The principle of joining rational water management with religion in the Balinese *Subak* irrigation system makes it very unusual. From a scientific perspective, combining these two schemes is incongruous. And yet, religious symbolism and mythology can convey centuries-old traditional knowledge about the local environment. *Subak* religious traditions in Bali have evolved over a millennium to produce a consistent system that manages natural resources equitably. Sacred rituals not only promote religious values, they are also the binding force for the social structure that enables farmers to cooperate rationally and generously through managing water distribution through a hierarchical system of temples.

Over the past millenium, the *Subak* system has enabled the Balinese to be among the most productive rice growers in Asia, providing a high degree of food sovereignty for a densely populated volcanic island. It has been a vibrant model of a diverse, ecologically sustainable, economically productive and democratic water management system. Per Olsson, who does transdisciplinary research on resilience and sustainability science, remarks that the Balinese cultural system is perfectly adapted to local ecosystem conditions: “We often talk of a social-ecological systems perspective and the need to reconnect to the biosphere, to realize our dependence on nature. This connection is visible in the way the *Subak* system operates. Farmers have developed a management system, embedded in ritual, in which their needs are met in the best possible way and in tune with the ecosystems they depend on.”²⁵

²² A. François-Simburger, 1998. *Politics of the Center in Bali's Cultural Periphery: Transformations of Power in an Old-Balinese 'Village Mandala'*. Ann Arbor, MI: UMI Dissertation Services, 71–73.

²³ “Hindu” Balinese believe that the environment is a gift from God(s). Extensive research has been done on how Balinese traditionally associate their natural environment with their spiritual and social environment. Balinese are culturally conditioned to perceive their relationships with the gods, nature and their fellow human beings as contributing to an intricate harmonious symbiosis. The natural environment is conceived dualistically, both horizontally and vertically, both physically and metaphysically. Physical, cultural, religious, social and psychological affinities are affirmed in daily activities and rituals.

²⁴ N.M. Yudiantini, “The role of traditional regulation in the indigenous villages for conservation of village pattern,” *21st International Sustainable Development Research Society Conference Tipping Point: Vulnerability and Adaptive Capacity*, ISDRS Society 2015, 7.

²⁵ M. Haeggman, *Feature*: “Resilience lessons from a water goddess,” 09 Feb. 2017 <https://rethink.earth/resilience-lessons-from-a-water-goddess/>

The case of the Balinese water temples supports the ideas of the Nobel Prize laureate in Economic Science Elinor Ostrom, who disputed Garrett Hardin's concept of the "tragedy of the commons." Hardin contended that resources available to all – in the commons – are doomed to be overused by everyone. Ostrom disagrees, arguing that local people who depend on a common natural resource have a greater stake in preserving it, and thus are more likely to constructively monitor and influence each other's activities. The Balinese have created a way to beneficially share their common resources, through centuries of developing cosmology and customs.²⁶ "In Bali it is so clear that people have understood the complex system in which they live, and that they have figured out how to act to make it work in the best possible way," says Miriam Huitric, director at the Stockholm Resilience Centre. "This type of deep understanding of a system meant that they could take care of the system in a way so that it could be resilient in the face of a number of different disturbances."²⁷

The Subak in Jeopardy

Sadly, despite establishing this apparently perfect order, the *Subak* system has faced numerous existential crises over the last half century.

In the 1940, Indonesia's inhabitants totaled 40 million, about three million fewer than Japan. Half a century later, Indonesia's population count had nearly doubled that of Japan, numbering nearly 200 million. During the 1950s, Indonesia switched from being a net rice exporter to importing nearly one million tons of rice a year to feed a rapidly growing population, in an era of political and economic instability. By the late 1960s, the Indonesian leader Suharto directed oil revenues towards setting up government bureaucracies dedicated to agricultural "modernization" policies, following Western technological practices and standards. Following the introduction of the "Green Revolution" to Indonesia, in 1971 Bali was selected as a prime location where agricultural yield could be increased by introducing Western farming techniques. It was proposed to apply "scientific thinking" to agriculture in Bali. New kinds of rice, chemical fertilizers and pesticides, mechanical harvesters, and specialized irrigation tools were promoted by government officials and adopted by many farmers. These new technologies heralded new regimes of water and pest management that supplanted the practical and ceremonial role played by *Subak* water temple priests.

To meet the goals of the "Green Revolution," the International Rice Research Institute in the Philippines developed a high-yield, disease and insect-resistant strain of dwarf rice, which yielded many more tons of rice per hectare than *Padi Bali*.²⁸ IR8 is a genetic modified cross breed that was bred using a rice variety called Peta (a variety particularly resistant to pests and diseases) and a short Taiwanese variety called Deegeoweegen that ripens quickly. This strain has been labeled "Miracle" rice or "New" rice. "Miracle" rice was introduced to Bali in the early 1970s. While traditional *Padi Bali* takes 210 days to from planting to harvest (the length of the Balinese year), "Miracle" rice requires only 120 days to mature, around half the time needed by

²⁶ V. Klinkenborg, "Self-Determination and the Problem of Economic Development" in Editorial Observer, Opinion sec.: A38. *New York Times*, 29 Sept. 2009, 28.

²⁷ Haeggman 2017.

²⁸ C. Schill, Ylva Ran, Daniel Ospina, Reinette (Oonsie) Biggs, "Balinese rice production" in *Regime Shifts*. Last revised 2017-02-07 11:26:51 GMT. <https://www.regimeshifts.org/item/60-balinese-rice-production>

traditional rice. This disparity prompted the Indonesian government to proscribe the planting of indigenous rice plants that matured slower, did not respond well to fertilizers, and produced less grain per acre.²⁹

At the urging of Asian Development Bank and the World Bank, the Indonesian Ministry of Agriculture issued “technology packages” with new seed varieties (IR8 and IR 36), chemical fertilizers and pesticides, and compelled farmers to use them. Government agencies instructed the Balinese farmers to abandon the native rice varieties and the traditional cropping patterns in favor of the continuous cropping of high-yielding hybrid varieties. By the mid-1970s, rice farmers had abandoned their traditional, coordinated cropping timetables to plant IR-36 as often as possible.³⁰ The fixation on planting rice crops back to back to boost production resulted in little to no communication, let alone cooperation, between farmers working in the same watershed. Balinese rice farmers ceased to follow the centuries-old cyclical cropping patterns and began using pesticides and fertilizers for the first time.

Over the first few years, there was a 43 per cent increase in rice production. Instead of growing three crops of *Padi Bali* every two years, Balinese rice farmers now had the capacity to plant and harvest three crops of “New rice” per year.³¹ But the modern intensive schedule for planting led to water shortages. Farmers downstream in the watershed started to notice that they couldn’t get enough water to flood their fields after harvest. “Miracle rice” also seemed to attract and sustain “miracle pests”, that could now move freely between the fields as paddies were left unflooded. Despite farmers’ increased use of pesticides, the pests managed to survive, feasting on the rice crops. Pest populations and crop diseases exploded.³² At the time, government planners dismissed these occurrences as coincidence, and they urged the farmers to apply higher doses of pesticides.

Pesticides were not the only chemicals introduced to Balinese paddies. Farmers had long experience with the island’s nutrient-rich volcanic soil, capable of producing high yields without the addition of fertilizers. But the “Green Revolution” mandated that farmers use synthetic fertilizers that were not absorbed by the rice plants, since Bali’s naturally fertile soil had already provided the plants with all the nutrients they needed. The surfeit of chemical fertilizers flowed in runoff water downstream and into the ocean, harming Bali’s nearshore coral reefs, that prefer phosphate-free waters. The reefs began to die.³³ Balinese coral reefs were also used as sources for material used in building roads and making concrete. The coral reefs had traditionally broken up the surf, but as reefs dwindled, tropical storms found free passage to wreck the inland ecosystem with salty storm surges.

²⁹ J. Melowsky, “Balinese Cosmology and its Role in Agricultural Practices,” 63.

https://www.hamilton.edu/documents/levitt-center/Melowsky_article.pdf

³⁰ J.S. Lansing and J. Miller, “Cooperation, Games, and Ecological Feedback: Some Insights from Bali” in *Current Anthropology* 46.: 2 (April 2005), 330.

³¹ Schill 2017.

³² J.S. Lansing and Karyn M. Fox, “Niche construction on Bali: the gods of the countryside” in *Philosophical Transactions of the Royal Society* 366: 1566 (2011), 932.

³³ B. Machbub, H.F. Ludwig and D. Gunaratnam, “Environmental impact from agrochemicals in Bali (Indonesia)” in *Environmental Monitoring Assessment*, 11:1 (1988 Jul), 10-11.

In 1977, although 70 per cent of the southern Balinese ricebowl was planted with “Green Revolution” rice, the Indonesian government pushed farmers even harder to use short rotation rice varieties, leading to a momentary suspension of the Balinese cropping calendar. New “Green Revolution” irrigation schemes intruded on traditional water irrigation timetables. Water temple *Padi Bali* rituals no longer matched the realities of “miracle rice” cultivation. Discontinuing traditional communal rice growing rituals made the *Subak* water temples and water priests irrelevant; they had already been discounted by outside agricultural technical consultants who advised the government. The “Green Revolution,” as a Western secular technology transfer initiative, had not accepted the value of indigenous religious ceremonies in guiding productive agricultural practices. Failure to understand their importance undermined a delicate ecological balance in Bali that had been developed indigenously over many centuries.

During the New Order/“Green Revolution” period, many *subaks* were appropriated by government to become channels for top-down edicts, with the result that their traditional self-governing, democratic procedures were phased out.³⁴ Coordinated, consistent agricultural practices were disrupted. Since farmers upstream appreciated the synchronized collaboration required during dry season to prevent pest infestations, they largely ignored the government mandate to change water temple calendar. Downstream, threats of legal penalties made by the Indonesian government compelled other farmers to cultivate the new rice varieties that required year-round irrigation. During the dry season, the supply of water fluctuated greatly and district agricultural office began to report “chaos in the water scheduling” and “explosions of pest populations”.³⁵ Despite the appeal of lucrative cash profits, many Balinese farmers began to yearn for a return to traditional water temple irrigation scheduling as the only effective way to combat pests. Foreign consultants dismissed this as reactionary superstition.³⁶

The Subak Returns

Countless centuries of carefully considered irrigation schedules had symbiotically linked water sharing with pest control. Within a decade, this system was subverted and abrogated by “Green Revolution” policies. By celebrating spiritual connections with agricultural deities, water temples had generated social groups that cooperated in ways that “new and improved” strategies completely overlooked. The *Subak* system had produced harmonious rice farming communities that could collectively resolve irrigation problems. These water temples were indispensable, not just as religious institutions, but as essential contributors to the agricultural productivity of Bali. As a point of fact, the “Green Revolution’s” uncoordinated planting methods (“every man for himself”) and non-responsive centralized, non-local supervision proved to be less effective than the *Subak* temple networks’ coordinated supervision of Bali’s agriculture. After a decade had passed, it became apparent that the “obsolete” traditional *subak* system provided benefits that “Green Revolution experts” had overlooked and could not restore.

³⁴ Lansing 1991:113; Arthawiguna et al. 2005:3; Poffenberger and Zurbuchen 1980:105; Spiertz 1991:192.

³⁵ J.S. Lansing and J.N. Kremer, “Emergent properties of Balinese water temples” in *American Anthropology* 95 (1993), 114.

³⁶ J. Stephen Lansing and James N. Kremer, “A Socio-ecological Analysis of Balinese Water Temples” in *Indigenous Knowledge Systems: The Cultural Dimension of Development*, ed. D.M. Warren, L. Jan Slikkerveer and David Brokensha. London: Intermediate Technology Publications, 1995: New York: 258-268.

The Indonesian government took nearly two decades to recognize the developing crisis. By 1988, the Indonesian government had become sufficiently alarmed that it flouted World Bank directives: Suharto's regime revoked its own government regulations to use only "Green Revolution" sanctioned seeds and chemicals. This led eventually to returning power to the *Subak* water temples to manage the Balinese irrigation systems and allowing farmers to revert to integrated pest management practices. Once most farmers returned to coordinated planting schedules, rice harvest yields began to recover, a fact subsequently confirmed by the final evaluation team from the Asian Development Bank: "Substitution of the "high technology and bureaucratic" solution in the event proved counter-productive, and was the major factor behind the yield and cropped area declines experienced between 1982 and 1985... The cost of the lack of appreciation of the merits of the traditional regime has been high."³⁷

Nevertheless, even after the change in Indonesian government agricultural directives, a significant percentage of Balinese farmers chose to continue to use the high-yielding hybrid rice strains, in tandem with pesticides and fertilizers. Since the modern agricultural tech-package is a capitalist enterprise, the "rice production – cash income" model was more persuasive to some farmers than the 'rice production – subsistence' model that was prevalent pre-"Green Revolution." Agronomists and engineers trained in Western industrialized countries had taught Balinese rice farmers to reject traditional agricultural and irrigation practices as archaic and unscientific. Neoliberal modernization's allegiance to a global cash economy had altered local social relations by transforming world-views, beliefs and values.

"Green Revolution" scientific experts never recognized the value of traditional collaborative practices in Bali that had led to successful collective farming over a millennium; they also failed to anticipate that Bali's rich volcanic soil could not absorb chemical fertilizers. These poisons began to leach through the soil into Bali's aquifer, polluting the most sacred resource of *Pulau Dewata*, "the Island of the Gods." Bali is struggling to recover from an ecological disaster that the "enlightened", technologically superior West produced. While the architects of the "Green Revolution" may have had good intentions, results proved that their values and methods were incompatible with local cultures and environments. Their top-down approach disregarded indigenous practices and knowledge that had successfully managed local environments for over a millennium.

Into the Future

The Balinese government estimates that presently there are 1559 subaks covering around 81,625 hectares of wet-rice sawah, 14.48% of Bali's landmass (BPS Bali 2013).³⁸ Recently, it has been calculated that about 1,000 hectares of wet-rice (paddy) land are lost each year.³⁹ The demands on labor, land and water resources will increase in future, given the ongoing conversion of Bali's economy from agricultural to service industries. We witnessed the scale of land conversion by tourism developers in response to mass tourism demand, which is accelerating. Pressure to reallocate irrigation water to competing higher priority uses (such as tourism) will continue to

³⁷ J.S. Lansing and W.C. Clark, *Priests and Programmers: Technologies of Power in the Engineered Landscape of Bali* (Princeton, NJ: Princeton University 1991), 124.

³⁸ A. Wardana, *Contemporary Bali: Contested Space and Governance* (London: Palgrave Macmillan 2019), 63.

³⁹ A. Neef, J.H. Grayman ed., *The Tourism-Disaster-Conflict Nexus* (Bingley UK: Emerald Publishing Group 2018), 39.

intensify. An aging village population has left a severely reduced agricultural workforce.⁴⁰ Younger Balinese are generally not enthusiastic about working in the mud of the rice fields. They are attracted to plentiful, less taxing, higher paying jobs offered off-farm by mass tourism and associated industries. Bali's remaining farming communities are struggling to survive with less labor, land and water.

The Nomination for the Inscription of the Cultural Landscape of Bali Province on the UNESCO World Heritage Regime acknowledges that "[as] long as farmers can only grow cheap hybrid rice, rising land prices and increasing living costs tempt them to sell their land and seek alternative professions" (Indonesia. MCT 2011, III-5).⁴¹ Professor of Agriculture First Name Sutawan at Udayana University has declared that farmland has been drastically reduced, particularly near urban areas because the price of land there tends to be high. "Farmers tend to sell their land instead of utilizing it when the harvest is not really promising. They are more likely to deposit the money from selling the land in a bank and wait for the monthly interest to be paid, which may exceed income from farming the land."⁴²

Bali currently faces two major environmental pressures concerning water: pollution and freshwater scarcity. Water is diverted from agriculture to tourism, to serve the needs of hotels, villas and golf courses; the mass tourism industry has become the largest consumer of water, accounting for 65 percent of water use in Bali.⁴³ The current environmental conditions are these: overall freshwater supply is limited, management of infrastructure is often neglected and demand is exploding. As more rice fields are lost to the tourism industry, water supplies have reached a critical stage as "water shortage is directly linked to loss of cultivated land."⁴⁴ This has driven some locals to resort to stealing from neighbors for everyday water needs.

Several people in Bali confirmed this printed comment by a Balinese: "Before we didn't have a problem with water, but now, when the dry season is coming, we have problems. Sometimes we have enough water. Sometimes we don't."⁴⁵ Altogether, the tourism sector has lowered the island's water table by some 60 percent. We were eyewitnesses to what open water there was in Bali often contaminated by trash. A local water resource researcher has observed that "The more we take water out of the ground the more we create a gap for salt water to fill that gap because there is a constant enormous pressure the ocean is putting on the land." Once Bali's aquifer becomes contaminated, the damage will be irreversible, explained the expert, who wished to

⁴⁰ R. Skeldon, "Aging of rural populations in South-East and East Asia" in *Sustainable Development Department Dimensions*, (Rome: Food and Agricultural Organization of the United Nations 1999 <http://www.fao.org/sd/wpdirect/WPan0029.htm>

⁴¹ Wardana 2019, 64.

⁴² N. Sutawan, "Eksistensi Subak Di Bali: Mampukah Bertahan Menghadapai Berbagai Tantangan" in *SOCA – Jurnal Sosial Ekonomi Pertanian*, 1:2 (Juli 2001), 3.

⁴³ A. Wardana, "Debating Spatial Governance in the Pluralistic Institutional and Legal Setting of Bali" in *The Asia Pacific Journal of Anthropology* 16:2 (2015) Paradise Contested: Culture, Politics and Changing Land and Water Use in Bali, 110.

⁴⁴ S. Strauss, "Water Conflicts among Different User Groups in South Bali, Indonesia" in *Human Ecology* 39:1, Studies of the Subak: New Directions, New Challenges (Feb.2011), 76.

⁴⁵ Jed Smith, "Bali's Tourism Is Sucking The Island Dry" in *Water Woes*, Vice.com (25 Feb. 2018) https://www.vice.com/en_asia/article/qvexem/balis-tourism-is-sucking-the-island-dry

remain anonymous in newspaper accounts after receiving death threats for previously speaking out on this issue.⁴⁶

Sadly, the water researcher's warnings have proved prophetic. A recent article in Al Jazeera from December 2019 notes that although there is a long history of Balinese sharing water resources through *Subak*, diversion of water to urban areas and overuse of groundwater by hotels is disrupting that system. Anton Muhajir, a Balinese journalist who has covered the water crisis in Bali for a decade, declares:

I believe that Bali is in real danger... Some of my friends have had to move from their ancestral homes in Denpasar because the water in their wells has turned salty. At Jatiluwih, where thousands of tourists go each day to see the most beautiful rice terraces of Bali, farmers are using plastic pipes to pump in water they have to buy in the south because the springs in the mountains are drying up.⁴⁷

Dewie Anggraini Puteri, fundraising officer for the IDEP Foundation, an Indonesian NGO focused on sustainable development, shares Muhajir's concerns:

The subak system is still being used by every village in Bali, but now they're fighting with people who work in tourism because their water sources are drying out and lots of paddy fields are disappearing as a result.⁴⁸

Bali faces multiple problems of shortages of land and water, environmental degradation from decades of petrochemical fertilizer and pesticide use, a growing imbalance between the rising costs of growing rice and low prices for the grain. Since 1990, twenty years after the advent of the "Green Revolution," an inexorable economic transfer has been made from agriculture to tourism, exacerbated by a growing reluctance of young people to take up farming.⁴⁹ And yet, the lush green terraced landscape that has been finely and devotedly maintained by the *subaks* over many centuries is an important tourist attraction in Bali. Continued tourism rests on its sustained existence. And for Balinese, the *Subak* is one of five recognized public corporations of present-day Balinese village polity, around which Balinese social life is organized.

In 2012, due to extraordinary efforts by the Indonesian government, *subaks* were inscribed on the UNESCO world heritage list as a cultural landscape, in recognition of Bali's unique water management system. The designation came with returning complete control over the agricultural landscape to the heads of the *subaks*, who would serve the original purpose of optimizing water sharing. For Balinese, *Subak* preserves local cultural heritage of the ways in which rice is cultivated, irrigated and celebrated.⁵⁰ Ironically, the world heritage listing made designated areas

⁴⁶ Smith 2018.

⁴⁷ Ian Lloyd Neubauer, "Bali: The tropical Indonesian island that is running out of water," *Al Jazeera*, 1 Dec. 2019 <https://www.aljazeera.com/news/2019/12/bali-tropical-indonesian-island-running-water-191201051219231.html>

⁴⁸ Jed Smith, "Bali's Tourism Is Sucking The Island Dry" in *Water Woes*, *Vice.com* (25 Feb. 2018) https://www.vice.com/en_asia/article/qvexem/balis-tourism-is-sucking-the-island-dry

⁴⁹ G.S. MacRae, 'Growing Rice After the Bomb: Where is Balinese Agriculture Going?' in *Critical Asian Studies* 37:2 (2005): 209.

⁵⁰ R P. Lorenzen, "Perseverance in the face of change: Resilience assessment of Balinese irrigated rice cultivation", PhD thesis for Resource Management in Asia-Pacific Program, Crawford School of Economics and Government, Australian National University, 2011, 284.

even more attractive to developers looking to increase tourism to the island. The ensuing “land rush” decimated the *subaks*, which currently diminish by about 1,000 hectares (about 2500 acres) every year.⁵¹

Conclusion

One of our Envirolab Asia Faculty Lab objectives in Bali was to study the Balinese *subak* water temple system to find ways to change how “developed” societies perceive indigenous cultures and their practices, to counter ingrained intellectual biases. “What I hope that people can learn from Bali is that if you arrive somewhere and there is a way of doing things there, pay attention to it,” Lansing has said. “Learn about it instead of immediately trying to change it. There is probably a reason that things are done in a particular way.”⁵² We particularly urge fellow Western scholars to be skeptical of the notion that new technological knowledge is inherently more effective or practical than the old. This is particularly apropos now, as *Subak*’s historically integral role in Balinese culture in connecting rice farmers to villages to water temple networks is clearly weakening, due to the fact that rice cultivation is no longer the major concern of most Balinese. With rice fields continuing to disappear and fewer incentives for the younger generations to engage in agriculture, the *Subak*, as a form of Balinese social organization that finds ways to cooperate collectively, is at risk.

In a 2015 special edition in the *Asia Pacific Journal of Anthropology* has conferred the title of “Paradise Contested” on Bali to describe the complexity of conflicting claims on its environment, landscape and water.⁵³ Indeed, the landscape of Bali is valued in different ways by different constituencies: developers appraise its economic worth; traditionalists find a social and historical meaning; and water priests uphold its sacred and ceremonial significance. The future of the *Subak* may rest on a paradigm shift: will the water priests remain cultural leaders, will they become superfluous due to the changing demands on water, or will they reinvent *Subak*’s role in Balinese society? How will the *Subak* survive?

Illustrations

⁵¹ M. Rawlinson and C. Ward, ed., *The Routledge Handbook of Food Ethics* (Abingdon UK: Routledge, 2017), 1.

⁵² Haeggman 2017.

⁵³ R.P. Lorenzen and D. Roth, “Paradise Contested: Culture, Politics and Changing Land and Water Use in Bali,” in *Asia Pacific Journal of Anthropology* 16 (2015)

Subak rice field, Bali; WikiCommons (accessed 10.24.19)

Offerings on the street; photo by Hao Huang (7.6.19)

Dewi Sri, Rice goddess; photo by Hao Huang (7.12.19)

Pura Ulun Danu Batur, temple of *Dewi Danu*, Goddess of water; WikiCommons (accessed 9.10.19)

Ulun Carik (near Ubud, East Bali); photo by Hao Huang (7.10.19)

Ulun Bedugul, near Ubud, East Bali; photo by Hao Huang (7.8.19)