Participatory Irrigation Management:
Social Organization in Natural Resource Management

Capstone Scholarly Essay

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Introduction

Irrigated agriculture has changed dramatically in the last 50 years and has in turn fostered change and economic development in rural communities. Numerous programs have been designed to encourage local farmer organizations to assume greater roles in finance, management, operation, and maintenance of their systems. Agricultural water is problematic to privatize because it is always in continuous flow. Under times of scarcity, these questions about management become more important for the livelihoods of agricultural communities. This paper is an assessment of the case studies of participatory irrigation in the context of Southeast Asia. I argue that notions of farmer participation and robust infrastructure are the most important factors of participatory irrigation management in the situated context, they integral components of community based natural resource management that should be promoted over centralized resource management. Firstly, I lay out theoretical frameworks associated with irrigation development and natural resource management. Then, I examine the cultural and geographic context of Southeast Asia as a site of participatory irrigation management. I then explain my methodology for analyzing these case studies with design principles of resource management. Then I discuss the results of this analysis and its relevance in relation to the broader context of community based natural resource management.

Background

Hydraulic Societies

Karl August Wittfogel described community irrigation systems and large hydraulic works managed by despotic states in mid-20th century Asia as "hydraulic societies"[1]. These systems were known for sustaining growing populations over long periods of time. They mirror two polarized modes of irrigation development, one centered on community management, the other organized and implemented by powerful states. Wittfogel states that he had "long been impressed with the developmental lessons to be learned from the study of agrarian societies based on large-scale and government-directed water works. These societies covered more territory, lasted for more years, and shaped more lives than any other stratified agrarian society." He argued that the necessity to muster the labor force necessary for huge flood-control works and irrigation systems was indicative of totalitarian organization. Specifically, he refers to the despotic empires of Ancient Egypt, Ancient Somalia, Dynastic China, and Sri Lanka. Wittfogel believed that these empires held common hydraulic hierarchies that were controlled by established institutions of governments who denied any possibility of structural change through revolution. Dynasties could be outlived or overthrown, but the infrastructure of regimes remained the same.

Large waterworks were created for both irrigation and flood control. Irrigation made it possible to acquire food surpluses. Improvements in irrigation and increases in food supply led to population growth. In some areas, efforts to continue the intensification of irrigated agriculture led to environmental problems such as salinization, siltation, flooding, and disease epidemics

[1]Wittfogel 1957

such as malaria. These environmental issues often led to the stagnation of crop productivity. As the productive limits of irrigation were approached, the hydraulic societies frequently moved into urban centers or annexed new territories in search of new resources. With today's growing concerns relative to environmental sustainability, it is worth noting that many of the old systems collapsed because societies could not manage environmental problems such as salinity, drought, or malaria.Wittfogel believed the epitome of the hydraulic society was China, which was built by demands for rice cultivation.

Critics have also pointed out situations where technologically advanced irrigation systems were not necessarily the result of a powerful, centralized, bureaucratic and despotic state (Bali Subak's[2], Sri Lanka[3]). Agro-hydraulic societies have historically supported high population densities. The centralization of the economy was sometimes paralleled by the achievement of large-scale infrastructures (China, India, and northern Vietnam), but this was not always the case (e.g., Kingdom of Majapahit in Java, in the 14th century[4]). In many populated areas of Southeast Asia, autonomous indigenous systems of communal irrigation were the norm. These earlier hydraulic developments already outline a dichotomy between large-scale, state-centered irrigation schemes and local communal systems. In both cases, the relation between water control and society is at the heart of the social fabric. Regardless of the direction in which causality runs, harnessing water on a large scale has been associated with the formation of many powerful states, while water was also a structuring element of community formation where small streams could be diverted or dammed for use in agriculture.

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[2]Lansing 1991
[3]Leach 1961
[4]Maurer 1990

The Commons

Community based natural resource management is a form of social organization that has members from the community act as equal common property resource managers. Studies in irrigation management have historically been focused on addressing poverty alleviation, food security, local profitability, and national revenue collection. The numerous programs designed to encourage local farmer organizations to assume a greater financial and management role in operation and maintenance have had limited amounts of success[5]. Community-based natural resource management (CBNRM) describes different approaches and practices that are focused on integrating social, economic, and environmental community goals by devolving authority in resource management away from central governments, towards local communities. CBNRM approaches are particularly applicable where land is communally owned, instead of where they are owned by private entities. CBNRM approaches are created to improve the status of the resource used, as well as the livelihoods of those who manage and live with them.

There is no definitive answer to the question of equity in CBNRM. Some scholars have questioned the ability for CBNRM to address inequity. The inequities of resource management occur when communities involved in resource extraction do not accrue proportionate benefits to their labor[6]. Others have claimed that CBNRM policies can result in higher degrees of political and economic equity[7]. The discrepancy should be understood as a contextual one, which depends on the degree to which facilitators of CBNRM intervene or engage with groups that been marginalized by policies. These people have historically been women, ethnically marginalized

[5]Barker and Molle 2014
[6]Agrawal and Ostrom 2001, Agrawal and Gupta 2005
[7]Coward 1990

groups, the disabled, and the relatively poor. Equity is not always compatible with sustainable natural resource management. In most cases, there is a tradeoff between the equitable distribution of resources (and higher quality of living), and more efficient resource management[8]. In a study of forest management decentralization in Vietnam, it was found that unequal relations between local authorities and communities led to the unequal distribution of community land. Although better forest management was achieved, it came at the cost of dispossessing lower-income communities[9]. Resource managers and communities are always struggling to find an appropriate balance between more efficient resource use and better communal livelihoods.

The tragedy of the commons is a theory of a social dilemma that was first brought to attention by the ecologist Garrett Hardin. Specifically, the title refers to the overgrazing of common land. Hardin believed that individuals acting out of rational self-interest and using common resources for their own gain, would eventually lead to resource depletion. Relying on altruistic conscience as a means of managing the commons is a poor decision because selfish individuals, also known as free riders, will benefit the most. The idea is that unrestricted demand for a finite resource eventually reduces the resource through over-exploitation. As the benefits of exploitation accrue, individuals or groups are incentivized to continue their exploitation, which causes the problem to snowball until the resource is completely depleted. Elinor Ostrom, a well known political economist, believed that Hardin's assumption about resource use were too simplistic. Hardin presumed that humans either require external authority, or must privatize, to manage common resources. Ostrom believed resource management does not require government intervention or private property. It can and should be done with local communities[10]. For this to

[8]Agrawal and Gupta 2005
[9]Mahanty et al. 2006
[10]Ostrom 1991

happen, users and suppliers must form a variety of institutional arrangements to cope with the characteristics of each system. Ostrom created eight design principles to assess community irrigation systems.

Situated Context

Rice in Southeast Asia

Geographically, this study is focused towards rice producing communities within both the inland sub-region and the island-based subregion of Southeast Asia. In 2010, The United Nations Food and Agricultural Organization reported that about 31% of global rice production is from this region[11]. Irrigated rice has the highest levels of productivity, and about 45% of farming land is irrigated in SE Asia. The production of rice is essential for its ability to provide efficient amounts of calories and nutrition, it is also important economically for its export value. In Southeast Asian communities, rice is more than just food: it is the central subject of economic policy, a determinant of national culture, and an important anchor in the maintenance of political stability. The decline of rice production has been steadily building in the the last few decades, with prices reaching historical lows in 2001, according to the International Institute for Water Management[12]. At the margin, rice prices reflect the willingness and capacity of exporting governments to subsidize rice exports, and of importing countries to restrict rice imports and protect domestic producers. It also reflects the degree of price and income volatility that governments in the major consuming nations are willing to pay[13]. Years of surplus or of shortfall in production have a critical impact on the demand and supply of the world market.

[11]UN FAO 2012
[12]Barker and Molle 2004
[13]Tabor et al. 2002

Community Irrigation

Community irrigation systems have been pervasive throughout Asian countries, serving a significant portion of total irrigated area[14]. While most have been relatively small in size, it is not unusual to find ones larger than 1,000 hectares. They have generally been created in mountainous or hilly areas in order to divert streams for agriculture, notably in regions such as the Himalayas, northern Thailand, Laos, Vietnam, China, Japan, the Philippines, and Indonesia. Community cooperation is most evident in areas of intense population pressure and limited water supplies, where the organization of community labor and management is essential for gaining access to and sharing water, as well as to minimize conflicts[15]. The growing trend of shifting from subsistence agriculture towards commercialization exposes these systems to new threats as communities are becoming affected by world markets. Water users are diversifying their economic activities, the cost of maintaining systems is increasing, seasonal rain patterns are changing, and competition for fresh water is on the rise. Increased socioeconomic heterogeneity as well as the intervention of state governments in the construction and maintenance of irrigation systems has often weakened social cohesion and collective action. In addition, deforestation, afforestation, and changes in land use have altered hydrological cycles and water quality, which have lasting impacts on communities that exist downstream of these entities[16].

Traditional rights to water have been affected by outside parties diverting water from the same sources, or by the state, who have frequently imposed large water storage and distribution infrastructure upon communal systems. Disputes over the privatization of water reflect not only

[14]Barker and Molle 2004
[15]Agrawal and Ostrom 2001
[16]Starkloff 1998

the conflict between local practices and more recent state intentions, but also the conflict between freedom of management and adaptation to sociocultural contexts. Privatizing common-pool resources is also symbolic of the desire for states to manage resources through top-down, capital-intensive, macro-focused strategies of development. The system of communal management and what comes under the more general term of common-pool resource management still offers an appealing option for water management, as opposed to more hegemonic practices of state or market-driven modes of regulation[17]. However, due to rising wages, migration to urban locales, technological changes and the decline of traditional agriculture; threats to the continuation of communal management raise questions about the adaptability of this form of management. The challenge right now revolves around creating institutions that can: allocate water equitably among users, integrate management of irrigation at farm and system level, as well as reduce the onset of social conflict. This analysis will examine the extent to which several case studies follow these values.

Water User Associations

Water user associations (WUA) are seen by many social scientists as an essential element for improved irrigation system performance[18]. Terms used to describe these types of associations consist of participatory irrigation management (PIM) and irrigation management transfer (IMT). PIM refers to a certain level of farmer participation that would increase responsibility in the management process. IMT is a more technical term that describes the process of having irrigation management shift away from a public institution or the state, towards a local entity[19].

[17]Ostrom 1994
[18]International Water Management Institute 2004
[19]Groenfeldt and Svendsen 2000

Historically, many irrigation systems in Asia were developed through PIM methods and techniques[20]. IMT represents a decentralization of agricultural control, with the goal of creating WUA's that follow PIM. Irrigation has developed dualistically, with more recent state-led systems being emphasized over community managed systems. As the construction of large public systems has gained national emphasis, donors and agencies have often ignored the presence of functioning communal irrigation systems and their means of local management.

The first formation of PIM in Asia were found the Philippines in the late 1970's. The National Irrigation Administration (NIA) sought to change the bureaucratic management irrigation systems in place at the time[21]. Being influenced by the successful functionality of community managed systems, the NIA decided that PIM would lead to higher quality operation and maintenance, as well as improved agricultural production. The program was supported by the Ford Foundation, the United States Agency for International Development, and the World Bank. Their objective was to transfer full responsibility for operation and maintenance, control of canals, and payment collection to water user groups over time. This transfer of agency did not completely come to fruition due to interior political issues, but similar programs began to grow again in the 1990's, partly due to the desire of many governments to reduce spending on irrigation[22]. In the past few decades, the World Bank has endorsed IMT as a main water management policy. In areas where IMT implementation has been successful, government spending and exterior agency involvement have decreased, maintenance has improved in many cases. However, there has not been any conclusive evidence of IMT leading to more productive

[20]Samad 2001
[21]Korten & Siy 1988
[22]Groenfeldt & Svendsen 2000

uses of irrigation water[23].

Water Management in Southeast Asia

The Mainland Southeast Asia subregion is composed of Cambodia, Lao PDR, Myanmar, Thailand, and Vietnam. Mountains and hills make up about two thirds of total area. The climate alternates between wet (May to October) and dry (November to February) seasons. Total irrigation potential in this region is around 14.4 million ha, 44% of which is in Thailand. In 2009, about 13.8 million ha has been equipped for irrigation, making up 8% of the region. Rice production accounts for 80% of irrigation agriculture. The Maritime Southeast Asia subregion consists of Brunei Darussalam, Indonesia, Malaysia, Papua New Guinea, the Philippines, and Timor-Leste. The region is mostly made up of lowland plains and swamps. The climate is tropical and monsoonal. Total irrigation potential in this region is around 12.2 million ha. In 2009, about 9 million ha has been equipped for irrigation, making up 6% of the region. Rice production accounts for 82% of irrigation agriculture.

Table 1 depicts irrigation figures for each country in the geographical area of study. It depicts total irrigated area, the irrigation potential of each country, irrigated area as a percentage of cultivated agricultural area, small-scale irrigation coverage in total area ("small" being determined by national regulations), large-scale irrigation coverage in total area ("large" consisting of greater area than the "small" indicator), as well as the year these measurements were recorded. This data is significant because each case study I examine comes from a different context, according to national politics, history, geography, and customs. Countries such as

[23]Samad 2001; Murray-Rust & Svendsen 2002

Brunei Darussalam, The Philippines, Thailand, and Vietnam all have more than 30% of their irrigation originating from small-scale systems.

Table 1: Irrigation in Mainland and Maritime Southeast Asia[24]

Country	Irrigated Area (ha)	Irrigation Potential (ha)	Irrigated Area as % of Cultivated Areas	Small Scale Context-based (ha)	Large Scale Context-based (ha)	Year of Study
Brunei Darussalam	1,000		17	1,000	0	1995
Cambodia	353,566		9	17,090	259,320	2006
Indonesia	6,722,299	10,886,000	18			2005
Lao PDR	310,000	600,000	27			2005
Malaysia	362,687	413,700	4.8	100,658	240,059	1994
Myanmar	2,110,000	10,500,000	20			2004
The Philippines	1,879,084	3,126,000	19	625,360	1,253,724	2006
Thailand	6,414,800	12,245,000	34	2,848,240	3,566,560	2007
Timor-Leste	34,694		16			2002
Vietnam	4,585,500	9,400,000	49	1,638,297	2,947,203	2005

The case studies that will be analyzed are from six of the countries shown in table 1. All of them are considered to be small-scale irrigation systems.

Methods

In order to understand institutions that practice participatory irrigation management, outside stakeholders must understands how rules, combined with physical, economic, and cultural environments, create incentives and results. If every irrigation system in the world is created based on these contributing factors, the variety of institutional arrangements would be immeasurable. These design principles were created as an attempt to explain certain key characteristics that contribute to the functioning of long-enduring participatory irrigation systems around the world. These design principles are[25]:

1. Clearly Defined Boundaries: Individuals or households with rights to access water and the boundaries they operate in are clearly defined. Without defined boundaries, local

[24] UN FAO AQUASTAT 2012
[25]Ostrom 1992

users risk losing their resources to outsiders who can attain the benefits of their resources without contributing to managing them.

2. Congruence Between Benefits and Costs: Rules that specify the amount of water users are allocated are proportional to local conditions, labor input, and/or monetary input. Those who receive higher proportions of water are also required to pay higher costs.
3. Collective Choice Arrangements: Individuals and households that are affected by operational rules are also able to modify these rules. These rules can be modified over time by water users. It is ideal for water users themselves to invest in the monitoring and sanctioning of these rules.
4. Monitoring: Monitors actively audit the physical conditions of irrigation schemes and the behavior of water users. They should be accountable to the users and/or consist of users themselves.
5. Graduated Sanctions: Water users who violate operational rules must incur punishment from other water users or officials that are accountable for them. These punishments must be proportional to the seriousness of the offense, and should be undertaken by participants themselves.
6. Conflict Resolution: Water users and officials have access to low-cost resources in resolving conflicts among users or between users and officials.
7. Minimal Recognition of Rights to Organize: The rights of water users to devise and organize their own institutions are not challenged by external authorities. Many participatory irrigation systems are not recognized by authorities, and may face the threat of external authorities using their power to support those against organization.

8. Nested Enterprise: Appropriation, provisioning, monitoring, enforcement, conflict resolution, and governance are all organized in multiple layers of enterprise. By having water users organized into tiers of specialized labor, they can take advantage of different scales of organization.

These design principles were created to emphasize social cohesion in natural resource management. I chose them as measurements because they are representative of successful long-enduring small-scale community irrigation systems, which were determined from 130 case studies located in Nepal[26]. These principles served as the criteria for how WUA's in Nepal were created, they also led to the formation of Nepal's Community Managed Irrigated Agriculture Sector Project (CMIASP), which was sponsored by the Asian Development Bank (ADB)[27].

This analysis was created as a means of judging the relative success of these case studies based on their adherence to Ostrom's design principles. I searched extensively for geographically relevant case studies of participatory irrigation systems from the last 20 years within the geographical context. Out of the many sources I examined in terms of adherence to the design principles, I chose the seven cases with the most secondary literature (articles, gray data, further studies) available. Each design principle was then set up as a prescriptor that would be given a rating out of five, which would be used to compare case studies from different geographical regions. The higher ratings for each design principle are based on accordance to the principles and social equity. All averages are depicted with three significant figures. This form of rating judges the success of the irrigation systems based on the literature and sources that are available and accessible. These ratings should be read with an understanding that they are more of an

[26]Agrawal and Ostrom 2001
[27]Pradhan 2000

evaluation of the literature available rather than that of farmer production. A rating of 1 meant that the design principle criteria was entirely not present. For example, in the Cavite Communal irrigation system, graduated sanctions were not present to address the issue of landlords free riding for irrigation services[28]. A rating of 3 meant that there was some mention of the design principle criteria. For example, in the Ngameoyeik irrigation system annual workshops are held to address conflicts. However, these workshops did not occur often enough to receive a higher score, the study also mentioned that they did not always reach full attendance[29]. In the case of a 5 rating, design principle criteria was met and praised in some way. For example, in the Nam Tan irrigation system, there was an effective congruence between benefits and costs due to equally allocated proportions of land and water, as well as fines for chiefs[30]. This component of the Nam Tan irrigation system was also supported in an assessment done by the United Nations Development Program[31].

Context plays an important role in determining how these communal systems function and adhere to design principles. In Vietnam, Laos, and the Philippines, policies in relation to communal irrigation have been in place since 1960. In Indonesia, policies concerning participatory irrigation in the agricultural sector only started becoming implemented in the 1990's[32]. Larger systems have tended to be more successful in having clearly defined boundaries and regulations. They appear to be more structured, but have relatively more challenges in terms of individual participant organization and organizational rights.

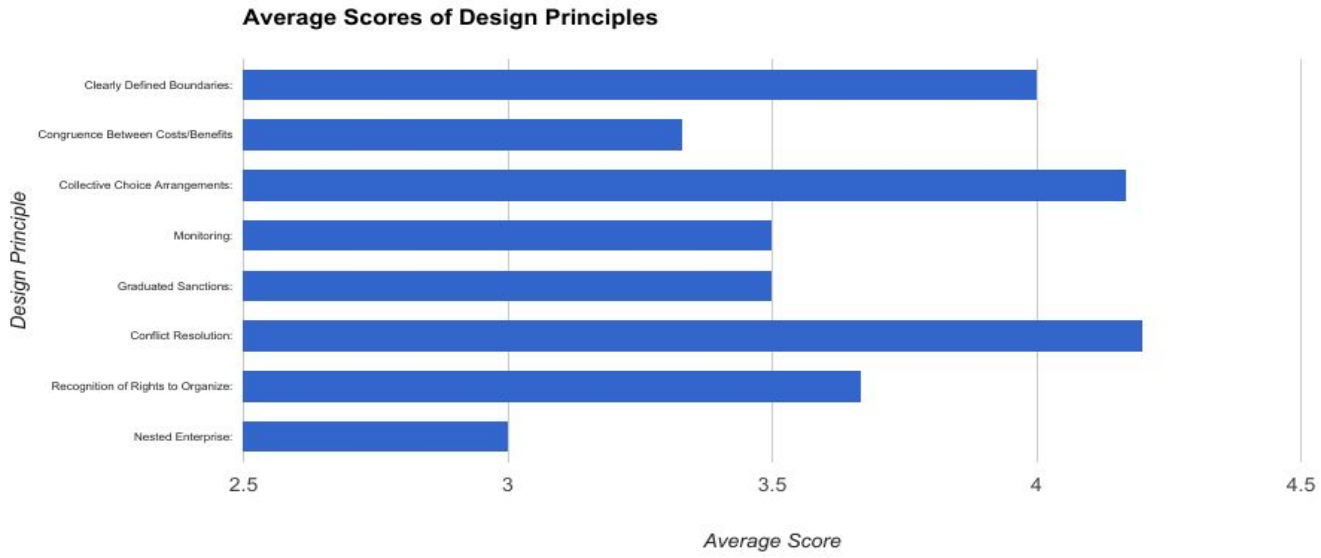
The goal of this analysis will be to see the degree of which these design principles are

[28]Kikuchi et al. 1997
[29]Matsuno et al. 2012
[30]Srinivasan 2015
[31]UNDP 1999
[32]UN FAO 2012

present in case studies from Southeast Asia. I compared the scores for each of Ostrom's design principles to see how prevalent they were in the case studies I analyzed. Out of the seven case studies that I have analyzed, three are from Indonesia, one is from the Philippines, one is from Myanmar, one is from Laos, and one is from Vietnam.

Results

Figure 1:



The results from figure 1 indicate that the three design principles that appeared to be emphasized most in the case studies are conflict resolution, clearly defined boundaries, and collective choice arrangements. All of these prescriptions received a score of four or more. To see how each design principle scored, along with justifications, refer to Appendix 1.1.

Clearly defined boundaries around a community of resource users allows each component to internalize positive and negative externalities produced by the users, they bear the costs of their work and receive benefits at equal rates with ideal management. In the Karya

Mandiri irrigation system, boundaries were set around a village that was 127 Ha. In the 1990's, the 40 Ha neighbour village of Salo also participated in irrigation services, and was implemented into the system while receiving equal access[33]. In Hop Tien Commune, an irrigation service area the size of 230 Ha provides services to 5,875 people, these boundaries are created using many lined and earth canals that are connected to a series of groundwater pumps[34]. The former system relies on an administrative boundary, the latter one relies on geo-physical features. Both case studies scored highly in this principle because they have well-defined service features and no mentions of free-riding.

Collective choice arrangements are present when users participate in modifying the operational rules of the irrigation system. This principle has often been mentioned as an integral part of community resource management because it is indicative of the presence of local knowledge[35]. In the Ngameoeyeik irrigation system, groups of farmers are in control of irrigation management, they are led by a 'water head' called Myaung Gaung. In a case study of the irrigation system, it was found that all farmers had proportionate amounts of ruling in deciding operational rules, as well as in bi-annual elections of the Myaung Gaung[36]. In the Karya Mandiri irrigation system, management is made up of a Group of Eight that develops through a democratic process where clan leaders work with farmers to modify rules when necessary[37]. In both cases, the structures of leadership are different, but farmers are involved in the decision making process.

[33]Helmi 2009
[34]Department of Water Resources 2008
[35]Berkes et al. 2000
[36]Matsuno et al. 2013
[37]Helmi 2009

Conflict resolution is most effective when low-cost mechanisms are in place, conflict over depletable resources is believed to be inevitable. In the Lembor irrigation system and the Subaks of Luwu, there are post-harvest board meetings where all conflicts are brought to attention and addressed. All farmers attend these meetings and issues are dealt with in a fair manner[38]. In the Karya Mandiri irrigation system, conflicts are resolved through integrated meetings between farmers, leaders, and local authorities involved in irrigation[39]. In these meetings, it is typically the village leader that decides how conflicts are resolved.

The design principle of 'Nested Enterprise' received the lowest score of 3. However, this was mainly because the case studies rarely mentioned any content related to organized enterprise, or tiers of labor. This is significant because most of the case studies expressed the importance of autonomy in social organization: where farmers are not accountable to other institutions[40]. Due to this ambiguity, I argue that three principles require further elucidation and improvement: congruence between appropriate costs and benefits, monitoring, and graduated sanctions. Social organization in the Lembor system fails to reach congruence between costs and benefits because periphery users, who put in equal amounts of labor, receive less water due to leaking channels[41]. Farmers involved in Subak irrigation in South Luwu do not contribute to the monitoring of their systems, they contract this duty to governmental WUA's. A case study found that WUA monitoring was inconsistent and did not involve farmers from the community[42]. In the Cavite communal irrigation system, graduated sanctions are not enforced well. The system receives a lot of voluntary labor from neighbouring villages, which means that landlords act as

[38]Lukman et al. 2012, Roth 2011
[39]Helmi 2009
[40]Helmi 2009, Department of Water Resources 2008, Roth 2011, Kikuchi et al. 1997, Matsuno et al. 2013
[41]Lukman et al. 2012
[42]Roth 2011

free riders and often do not put in adequate amounts of labor. Since they are the ones who own property, they receive equal amounts of water, but do not receive sanctions for free-riding[43].

Discussion

Through examining the case studies, there were two common concepts that stuck out to me in the results: farmer participation and robust infrastructure. Often times, irrigation management is exercised through local authorities, government officials, and contracted third party workers, irrigators themselves are rarely the ones managing their systems. Greater farmer participation in management can have both economic and social benefits. Economically there is evidence that farmers perform more efficiently than outside agencies when they feel a accountable for what they are managing[44]. Social benefits include the organizational skills that are developed based on self-reliance. Collective choice arrangements in this context are more apparent when farmers receive greater agency in management. Participation and farmer empowerment requires a deliberate effort on the part of non-governmental and government agencies. Achieving sustainable systems of resource management requires for infrastructure quality to be constantly monitored. Having robust infrastructure refers to having efficient means of water transfer, as well as mobilizing people to keep infrastructure intact. Clearly defined boundaries and monitoring in this context show how important it is for irrigation systems to have robust institutional infrastructure.

[43]Kikuchi et al. 1997
[44]Groenfeldt 1988

There does not appear to be any similar overarching theme to the design principles that scored low. This could be due to factors such as measurability, scope of research, interviews choices, along with other methodological decisions.

Every country and region has a different sociopolitical relation to irrigation management, and these factors are significant determinants of how successful they are. The performance of each system is relative and should not be held to a stern definition. Ostrom's design principles are useful tools for diagnosing and explaining why some projects are not sustainable, and they can also be used for prescribing alterations in operation and maintenance, so long as such reforms remain steady ongoing processes that involve consensus from all water users[45]. In assessing design principles of participatory irrigation, it should be noted that it is difficult to match rules to local circumstances. Not all participatory irrigation systems exist within similar contexts, long-term sustainability is not always equivalent to optimal production and food security. These principles should be understood as incomplete, and needing additional criteria for management that takes into account all contextual social variables. They are characteristics of communities and institutions, and even though these factors are important for system functionality, the most effective aspects of system functionality are intangible social mechanisms such as trust, legitimacy, and transparency[46].

Ostrom believed that sets of rules that are used for socio-ecological purposes should be dynamic as developments accrue. At the same time, people will devise ways to evade rules and re-create the tragedy of the commons, successful common resource management requires

[45]Ostrom 1992
[46]Harkers 2005

evolving rules[47]. Ostrom's concept of adaptive governance suggests that current systems should be adapted and reinterpreted to meet changing contextual conditions. Adaptive governance is necessary for further irrigation management in self-governing rice-producing communities to continue their practices. The concept of adaptive management suggests that current systems should be adapted and reinterpreted to meet changing contextual conditions. The strength of adaptive management lies in its ability to establish experimental approaches to resource management, as long as they are decided on consensus. Adaptive management functions continuously and cyclically.

Reforming Design Principles

To improve upon the three principles that were lacking in the case studies, I propose dividing the principles of congruence between appropriate costs and benefits, monitoring, and graduated sanctions into more specific criteria. Subdividing environmental problems of systems into sets of issues to address different types of problems allows for moving focus towards recognizing complexity. This can be useful in developing methods of understanding variables of incentives of water users under a variety of contexts. Specifically, this would be categorizing problems through making a distinction between community organization issues and problems related to public goods. An example of this would be to have separate policies for addressing farmer organization and rice harvesting techniques. Table 2 displays suggested alterations to the original design principles in the context of this study.

Table 2:

Design Principle	Ostrom's Criteria	Proposed Reform

[47]Agrawal and Ostrom 2001

2. Congruence Between Benefits and Costs	Rules that specify the amount of water users are allocated are proportional to local conditions, labor input, and/or monetary input. Those who receive higher proportions of water are also required to pay higher costs.	Congruence with local conditions: appropriation and provision rules are in accordance with social and environmental conditions Appropriation and provision: the benefits obtained by water users are proportional to the amount of inputs (labor, materials, and money) as determined by provisional rules
4. Monitoring	Monitors actively audit the physical conditions of irrigation schemes and the behavior of water users. They should be accountable to the users and/or consist of users themselves.	Monitoring users: Monitors who are accountable to water users monitor the work of the users Monitoring resources: Monitors who are accountable to water users monitor the condition of stream infrastructure
5. Graduated Sanctions	Water users who violate operational rules must incur punishment from other water users or officials that are accountable for them. These punishments must be proportional to the seriousness of the offense, and should be undertaken by participants themselves.	Determining sanctions: Sanctions on water users who are in violation of operational rules are equitably determined by an authority that is accountable to all water users Sanctioning resources: Water users in violation of social agreements are subject to a sanctioning of water use by an authority that is accountable to water users

Participatory irrigation management is just one example of ways in which communities come together to manage natural resources with limited outside intervention, although there is still more work that needs to be done. Community based natural resource management has

recently become an important aspect of development discourse. Such projects have received more support from donors recently because they are believed to address the political, ecological, and developmental goals of a wide range of actors[48]. There are still questions that need to be addressed regarding how these various actors are affected by community based resource management. Do external authorities share the same ideas as communities? Are these communities always isolated from larger systemic forms of development? Few studies have investigated the long-term social, ecological, and economic outcomes of these systems, or compared them to the status quo of alternative systems of resource management. This is problematic since it is always a challenge to determine variation in management systems between ecological and social contexts. It is also challenging to causally relate these variations to methods of social organization. Factors including the size of user groups and the type of government regime within which users operate are clearly important to consider. This study does not reject Ostrom's design principles in any way, it is a reminder that they need to be continually built upon and improved in accordance with local contextual frameworks. The idea of the tragedy of the commons being the inevitable outcome of communal natural resource management should be rejected. Under Ostrom's framework, groups of resource users can continue to enjoy the benefits afforded to them while also ensuring that common resources will continue to be managed by future generations.

Governmentality & Environmentality

The ideas of of participatory irrigation management, and CBNRM, can be understood as microcosms of larger concepts of governance. Michael Foucault's theory of

[48]Madzudzo et al. 2014

Governmentality is especially relevant in relation to rethinking conventional approaches to governing common resources. Governmentality operates as a means of producing governable subjects, who then continue to perpetuate the ideas of the subject-maker (government). It is the organized practices, attitudes, beliefs, and customs through which subjects are governed[49]. Under the western neoliberal form of government, the Tragedy of the Commons becomes a part of the governmentality of the subject, where governance over natural resources are centralized and privately owned. The design principles of participatory irrigation management and other practices of CBNRM are indicative of Arun Agrawal's concept of 'Environmentality', which holds that human beings collectively manage natural resources based on environmental pressures. It is an alternative to Governmentality that holds resource managers as the subject, and nature as the subject-making force[50]. In a study from the village of Kumaon, India, Agrawal explored the ways in which revolt against colonial regulatory strategies led to more equitable forest management that allowed for decentralized governance of the commons. British colonial forest regulations initially made livelihoods difficult for many in Kumaon, but as the villagers began to organize, they resisted state practices by setting forest fires. Regulatory power began to decentralize away from external authorities, ideas of self-governance ultimately led to the creation of forest councils, which conserve forest resources more efficiently than the state did[51].

Environmentality should be regarded as an alternative to governmentality, it promotes decentralized adaptive governance and collaborative strategies of resource management

[49]Foucault 1991
[50]Agrawal 2005
[51]Agrawal 2005

based on communal connections to locale. A public ownership of the commons empowers local populaces to exist outside the confines of centralized governance.

Conclusion

In this paper, I have used theoretical and historical frameworks to introduce the concept of participatory irrigation management as a form of CBNRM. Through analyzing design principles of several case studies in Southeast Asia, I have highlighted the importance of farmer participation and robust infrastructure, as well as suggest possible improvements to the design principles. Throughout this paper, I have presented participatory irrigation management as an alternative to privatized resource management, and have stressed the importance of community inclusion in institutional management. These institutions will take time to establish, but the task is monumental for the future of many communities that practice resource self-governance.

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Appendix

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