

**Social Engineering or Participatory Problem-solving?
A Practitioner’s Perspective on Opportunities for Irrigation Co-management**

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Abstract: Bureaucratic programs for involving water users in irrigation governance are challenged by inherent conflicts, contradictions, and asymmetries of power and knowledge. Government aspirations for acquiescence or devolution falter in the face of complexity, contestation, and interdependence. Idealized narratives of orderly irrigation clash with the messy bricolage of practice. Nevertheless, participatory programs may open meaningful opportunities for negotiation, cooperation, and polycentric governance. Drawing on examples from Aceh, Java, Bali, and broader international experience, this paper examines tensions, lessons, and opportunities for adaptive co-management in irrigation.

Keywords: water user associations, participatory irrigation management, co-management

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INTRODUCTION

In 1963, the Acehese religious and political leader, Daud Beureueh, led the digging of a seventeen-kilometer long irrigation canal in Pidie District, resolving a long-standing conflict created by a previous canal (Siegel 2000:60-67). This was one of a variety projects, to build mosques, roads and bridges, led by Daud Beureueh, who had earlier headed the All-Atjeh Union of Religious Scholars, been military governor of Aceh during the Indonesian revolution in 1945-46 and then led a rebellion against the central government from 1953-1961 until a settlement was agreed in 1962. While farmers whose lands would benefit formed the core of the workforce to build the canal, it was only possible through the assistance of many others, who, Siegel argues, were inspired to carry out the work as part of a religious duty, something set apart from everyday life, and which would be rewarded in the hereafter.

The role of earlier Acehese leaders in irrigation development was noted by Snouck Hurgronje, (the ethnographer who helped mastermind the Dutch conquest of Aceh) saying that an irrigation tax was collected “in districts where irrigation canals had been constructed at the behest of rulers in ancient times, ...” (1906: 272).

The influential role of political leaders in organizing multi-village efforts to build and improve irrigation, in Aceh and elsewhere, is an example of the persistent importance of politics and collective action in irrigation development. While the smallest irrigation systems may be built and managed by a few neighbors or a single hamlet, many require overcoming the challenges to organizing larger-scale cooperation.

Top-down state control of large irrigation works was central to Karl Wittfogel's concept of hydraulic bureaucracies, which he contrasted with the "hydroagriculture" of small-scale irrigation (1957:3,18). However, locally-initiated irrigation development may also build extensive infrastructure with large-scale impacts. Edmund Leach (1981 [1959]) critiqued Wittfogel by pointing out how reengineering of landscapes by massive hydraulic works, as in Sri Lanka, could result from cumulative construction over decades and centuries, rather than necessarily being the product of a single despotic mastermind. More recently, analysis of Balinese irrigation by Stephen Lansing (1991, 2006) and colleagues has clarified how irrigated landscapes may evolve through an emergent self-organizing process of complex adaptive systems.

The differences between top-down bureaucratic construction and bottom-up local irrigation organization have been a central theme in social science literature on irrigation. This concern has continued in the context of recent reforms aimed at decentralization through participatory irrigation management (PIM) and irrigation management transfer (IMT).² In many areas of natural resources management, the need to understand the interplay between institutions at different levels of resource governance, for example irrigation systems, river basins, and nation-states, has emerged as a major concern (Young 2002). The variety of attempts at decentralizing governance and empowering community-based natural resources management undertaken in many sectors in the last few decades have now led to a process of rethinking the limits and lessons of decentralization (see for example Agrawal and Gibson 2001).

This paper looks at some interactions between state agency intervention and local collective action in irrigation, seeking to highlight the potential for co-management. It draws on experience and examples from Aceh and other parts of Indonesia, while seeking to address wider questions about the potential and problems of developing co-management. The next section outlines patterns of episodic mobilization, suggesting that these may characterize local irrigation management in many contexts. Bureaucratic intervention often overlays new institutional arrangements, and, as the third section discusses, may yield, not the obliteration of customary practices or imposition of standard procedures, but instead a combination of institutional concepts and practices. Attempts at devolving irrigation management have met mixed results, and the potential exists for more focused attempt to improve cooperation between irrigation communities and government agencies in carrying out key tasks in irrigation construction and operation. The fourth section looks at opportunities for joint problem-solving and adaptation, particularly in participatory design, wider networking, and joint problem-solving to improve irrigation operations and water delivery. The final section of the paper offers conclusions about how adaptive co-management may weave a polycentric bricolage of diverse institutions and understandings.

EPISODIC MOBILIZATION

In Aceh, as in many monsoon climates, local collective action to irrigate rice typically follows an episodic pattern of mobilization, focused on pre-season canal cleaning and other key events. Those who share water usually join together in *kenduri blang* feasts, before and after the cropping season. Such mobilization responds to annual cycles of monsoon rains, shorter-term fluctuations between rainfall and dry spells, and longer-term extremes of drought and flood. Traditionally, the need for large amounts of labor to repair and rebuild diversion works once or more per season acted to unite those who shared water from the same stream or river. The ability to rapidly mobilize large amounts of labor and materials was crucial to deal with weir washouts, canal breaches, and landslides that threatened access to irrigation water. Rights to water were linked with obligations to contribute to irrigation construction and maintenance. However, the application of rules was often flexibly adapted to the fluctuating abundance and shortage of water, through shifts between different sets of rules, such as switching to rotational distribution of irrigation water during periods of shortage, with more relaxed and tolerant sharing during periods of plenty.

Narratives of indigenous irrigation have often concentrated on areas with intricate organization and autonomous irrigation organizations, such as the *subaks* of Bali (Geertz 1980), *muang fai* systems of northern Thailand (Potter 1976, Sirivongs Na Ayuthaya 1983, Tan-kimyong 1995), and the *zanjera* schemes of the northern Philippines (Lewis 1980). Often these systems carefully allocated water in proportional shares, with requirements for labor contributions matched to benefits.

Such accounts sometimes omit or gloss over the complications, conflicts, and improvisation that lie behind the performance of such “traditional” irrigation systems. Thus, for example, the identity and affiliation, of a “subak” could be a complex and highly contested matter, reflecting struggles within and between local communities (for example, see Spiertz 2000). In many irrigated areas, patterns of organization are more informal, ad hoc and improvisational than suggested by accounts of well-organized systems. Among other things, the extent of organization may reflect factors such as differences between whether water flows are stable or fluctuate greatly, and the level of dependence on irrigation rather than rainfall.

In contrast to famous examples of irrigation systems in Bali organized in ways that were relatively autonomous from local government, irrigation systems in Aceh have a long history of close linkage with village government (Coward 1991). Irrigation leaders were usually appointed by village (*kampong*) heads, typically reflecting a local consensus among farmers, with the *keujreun blang* watermasters having a recognized role in local leadership. However, this changed with the reorganization of village government resulting from Indonesia’s 1979 Law on Village Government. This established a local government structure with no place for Aceh’s *keujreun blang* watermasters. Traditional *ulu-ulu* watermasters were similarly displaced in Java. What had been an acknowledged position in village government was no longer recognized by law. However, in Aceh as in Java and other parts of Indonesia, communities have frequently perpetuated the institution of *keujreun blang*, as part of sustaining patterns of episodic mobilization that are responsive to both water users and village leaders.

BUREAUCRATIC BRICOLAGE

As in many places, bureaucratic attempts to develop irrigation in Aceh have often sought to impose new organizational forms, a form of “social engineering.” During the 1980s, the Indonesian government invested a portion of its revenues from oil and other natural resources in irrigation and other forms of rural development.³ In Aceh, government projects built permanent diversion weirs and extensive canal systems on many of the rivers that flow to the north and east coast. These often incorporated irrigation canals that had previously been built and rebuilt by smaller communities. Along with new physical structures, the government sought to put in place new organizational arrangements. These were supposed to follow national doctrines for “technical” irrigation management. Irrigation system designs were based on standard procedures for operation and maintenance, specifying how water was to be distributed by dam and gate operators. Irrigation management took place within the top-down apparatus for controlling cropping patterns, which had been imposed during the nineteen-seventies as part of the Green Revolution expansion of High Yielding Varieties through centralized programs. The role of farmers in irrigation management was supposedly limited to the lowest level, below tertiary outlets, which typically served from fifty to one hundred fifty hectares.

National standards for irrigation operation and maintenance are based on experience in Java, particularly old irrigation systems, some dating back to the nineteenth century, with relatively high levels of staff, with long experience in irrigation operation and maintenance, operating with relatively scarce water supplies during a long dry season. Standard procedures assume adequate funding for operation and maintenance. In practice, the condition of infrastructure, hydrology of water flows, cropping patterns and other conditions frequently mean that it is difficult or impossible to actually operate the irrigation system as designed, in Aceh and in many other parts of Indonesia. It is tempting to blame shortcomings in irrigation performance on difficulties in staff, budgeting, coordination, and other institutional factors. This has underlain concepts that reforms in irrigation governance, such as PIM and IMT would be a necessary part of improving performance.

The pattern of irrigation organization promulgated by the Indonesian government fit the New Order regime’s strategy of political demobilization of rural communities, restricting organization above the village level and subordinating local institutions to the hierarchical control of national organizations. The politics of power were practiced through manipulation to produce the show of consensus (*musyawarah dan mufakaat*) and compliance with government policies and commands. In practice, this was often a matter of imposed compliance with officially prescribed policies underlain by intimidation of potential opponents and behind-the-scenes brokering of conflicts.

The general pattern of restricting farmer activity to the tertiary level, “below the outlet,” reflects common policies in many countries. Management at the secondary canal level and higher was ostensibly monopolized by agency staff. Field observation and research (for India, see Chambers 1988, Wade 1987) have revealed the many ways in which local farmers may influence higher level water distribution, through direct action to operate gates and take water, lobbying, corrupt payments, sabotage, intimidation and other means.

In Aceh, as in many other parts of Indonesia, the lack of staff and budget often meant that in practice farmers took a much larger role in management, often working in cooperation with the available government staff. Although the budget year officially began in January, agencies often had no funds for maintenance until July or even later in the year, necessitating mobilization of users if urgent repairs had to be carried out before then. In practice, budgets were often late, inadequate or diverted to other activities such as minor construction contracts that better fit the interests of officials with discretion over their disbursement. Staffing levels were low, with meager wages, so that staff were not well-motivated to carry out their responsibilities. During the conflict period, security fears further reduced government presence in the field. All these limitations on government agency action created a situation where farmers were often left to their own devices, to do what they could, with only very limited support from government staff and budgets.

Bureaucratic efforts to organize formal water users associations (*Perkumpulan Petani Pemakai Air, P3A*) continued through the nineties and beyond. Nominally, the traditional *keujreun blang* irrigation institutions were recognized, since the official name for water user associations in Aceh was *P3A Keujruen Blang*. It was recommended that the former *keujreun blang* become WUA heads or technical staff (*Pelaksana teknis*). However, the internal structure was a standardized arrangement with a head, deputies, secretary, and treasurer, and a board of leaders (*pengurus*) often chosen to represent different parts of the irrigation system. WUA constitutions and by-laws, written in Indonesian, the national language, not in local language, followed a standard example that had been attached to the 1992 Governor's Decree on P3A.

Establishment of a formal water users association was often a condition for receiving government assistance. In practice, as elsewhere in Indonesia and many other countries, what often resulted was the establishment of paper organizations, while collective action in irrigation continued to be organized largely along previous lines. From the government perspective, organizations had been established. Meetings were held, officers selected and training courses conducted. Such training programs sought to build a common understanding of the importance of WUA and the proper procedures to be carried out. Subsequently, when necessary, WUA could hold meetings and put on a show of following the prescribed patterns for WUA activities, especially if it would enhance the prospects of receiving government aid for canal repair and improvement. Some selected sites received special attention, as "pilot" sites entered into WUA competitions (*lomba*) at the district, provincial, and national level.

However, much of what was expected of WUA did not happen. Officials bemoaned the inability of most WUA to keep proper records, collect monthly fees (*iuran*), and enforce government-mandated plans for water distribution. Evaluation of WUA development concentrated on conformity with formal requirements for preparing and implementing plans and filling in record books, highlighting the deficiencies of most WUA on such criteria. Thus, most WUA were categorized as "under-developed" or "not yet developed," while closer examination even of those categorized as "developed" usually revealed large gaps between what was done on paper and in practice. At the same time, farmers sharing a source of irrigation water typically continued to come together before each season to clean canals. Cropping patterns and schedules were announced at

kenduri blang feasts attended by local leaders and other farmers, (although this traditional forum was incorporated into subdistrict, *Kecamatan*, government procedures). *Keujreun blang* watermasters supervised water distribution, helped to resolve conflicts, and after harvest collected contributions from farmers, to pay for repairs and compensate their work.

It is tempting to portray this pattern of irrigation organization in terms of dualism, emphasizing the gaps between policy and practice, the discontinuities between bureaucratic prescription and local customs. Thus, the outcome could be depicted in terms of the strong disjunction between the formal procedures government sought to impose and the traditional patterns communities continued to practice. The story could also be narrated in terms of domination and resistance, as bureaucratic attempts to control resources are ignored, opposed, subverted, reinterpreted, and otherwise manipulated by the victims of state power. Such depictions do capture part of the story, of differences in perceptions, practices, and power.

However, a dualistic interpretation oversimplifies the extent to which government-introduced arrangements did influence local management practices, through various factors including the attractiveness of government financial aid, the use of government terminology to discuss and justify irrigation water distribution, and the influence on local leaders of training, government-mandated crop planning, and relationships with water resources agencies and other parts of local government. Government efforts to impose new organizational forms did not erase or eliminate previous concepts and practices. Neither did they just create a separate superficial layer of organization on top of local customs.

Instead, the pattern may better be characterized as a bricolage (Cleaver and Franks, 2003)⁴, mixing old and new concepts and practices, with substantial variation among communities and with dynamics responding to availability of subsidies and political backing for those who could comply with government-mandated organizational forms. The dynamics of irrigation management form an improvisational combination of ideas and institutions in which both state officials and local people are active agents. Understanding the organization of collective action in irrigation as bricolage also better comprehends the ways in which local actors opportunistically seek out state assistance while state agents pragmatically pursue accommodation between local traditions and new organizational forms. By highlighting agency and opportunity, such a perspective can help identify opportunities for creative co-management, rather than pretending that a solution might be found in either more complete implementation of national norms, or in state withdrawal.

FROM DEVOLUTION TO CO-MANAGEMENT

During the eighties and nineties, various initiatives sought to introduce more participatory approaches to irrigation management in many countries. Many of these focused on reducing government roles in irrigation, often justified by hopes that costs of operation and maintenance could be shifted from government to water users. The emphasis and objective was often framed in terms of shifting tasks and responsibilities from government to farmers. In Indonesia, this included a program to turn over small irrigation systems to water users associations and the development of WUAs and WUA

federations in larger irrigation systems to take part in collecting irrigation service fees and deciding how they would be used.⁵ These represented an attempt to shift away from a highly hierarchical and technocratic approach where decisionmaking was controlled by government, and farmer roles restricted to activities within tertiary areas. With the end of the Suharto regime in 1998, political reformation brought increased acceptance of principles of participation and democracy, opening new opportunities for participation, as well as hasty efforts to decentralize many roles and responsibilities, including transfer of irrigation systems to district governments.

At the national level, in the late 1990s, the Indonesian government agreed to an ambitious program to reform irrigation and water management institutions, supported by the Water Sector Adjustment Loan (WATSAL) from the World Bank. This program was supposed to include transfer of irrigation governance authority to water user association federations, replacing and going beyond activities under the earlier turnover and irrigation service fee programs. However, projects to expand implementation of the new program, with support from the World Bank and Asian Development Bank, went through a process of prolonged preparation, extended negotiation and delayed implementation.

In 2004, Indonesia enacted a new Water Law, and in 2006 a new Government Regulation on Irrigation was issued to follow up on the Water Law. These nominally endorsed participation in irrigation management, but, in contrast to earlier reform commitments, implicitly constituted a decision not to proceed with any ambitious program of irrigation management transfer. Draft regulations on irrigation management, prepared as part of the WATSAL program, subsequently underwent a long period of revision. Revised guidelines and manuals, which finally began to be issued in 2007, largely reiterated past practices for technical irrigation management. This prolonged period of policy shift and uncertainty created somewhat of a policy vacuum for projects such as irrigation rehabilitation in Aceh.

In Aceh, during the nineties and thereafter, attempts at reforming irrigation institutions had played out in the context of armed conflict and military repression. Expenditure on irrigation construction was one of the ways the government sought to offer benefits and align interests to obtain support in its conflict with the Aceh Independence Movement (GAM). In the wake of the December 2004 earthquake and tsunami, armed conflict was finally halted by the August 2005 Memorandum of Agreement between the government and GAM. Post-tsunami national and international assistance brought funding for investment in irrigation reconstruction and rehabilitation. This took place in the national policy context described above, where major efforts for more participatory irrigation governance had begun, but then faltered.

Post-Suharto decentralization reforms meant that officially, authority over most irrigation systems had been transferred from national and provincial governments to districts (*Kabupaten*). Irrigation infrastructure assets had been transferred to districts, and they became responsible for hiring and paying operations and maintenance (O&M) staff. In Aceh, turnover of secondary canals within irrigation systems to water user associations had never been implemented. Officially, water user association activities were still focused at the tertiary canal level and below. The pattern was thus one of devolution of irrigation management down to a lower level of government, but with little impetus for further devolution to user groups.

Projects funded by the national government and international aid continued to be implemented through special purpose project implementation units. These were separate from the routine administrative structure of district and provincial water resources agencies. The Asian Development Bank's Earthquake and Tsunami Emergency Support Project (ETESP)⁶ offered grant funding for reconstruction and rehabilitation work in a range of sectors, including irrigation. It sought to involve communities in the planning and construction of irrigation rehabilitation. However, irrigation construction and rehabilitation was still carried out through such special project implementation units. Initially for irrigation rehabilitation in Aceh, this was arranged through a project management unit directly appointed by the national government's Directorate General of Water Resources Development. Subsequently, control over this and other externally-funded reconstruction and rehabilitation activities was transferred to the specially-created Agency for Reconstruction and Rehabilitation in Aceh. Within the project, project managers controlled the flow of funds for civil works. District governments had a formal responsibility for approving project proposals, and continued to handle operation and maintenance of the improved schemes, but relatively little influence over implementation.

Within government, there was significant ambiguity and uncertainty about responsibility for irrigation. The Explanation (*Penjelasan*) of the 2004 Water Law stated that "responsibility" for irrigation operation and maintenance would be divided in accordance with irrigation system size, with districts responsible for irrigation areas under 1,000 hectares, provincial government responsible for those 1,000 to 2,000 hectares and the national government responsible for areas larger than 3,000 hectares and similar language was included in the 2006 Government Regulation on Irrigation. The ways in which this would be put into practice were not specified, and hypothetically could include various forms of delegation of funding and tasks to lower level government units. In Aceh, schemes were not formally transferred back to national or provincial management, although the national government provided some funding for O&M, channeled through project activities under the supervision of the provincial irrigation office.

Implementation of reforms to devolve authority to WUA faces challenges since agencies tend to oppose reforms that would reduce their power. This factor affected attitudes towards reforms in irrigation management, such as proposals for irrigation management transfer. However, as part of decentralization, much more drastic shifts were actually implemented, most notably the transfer of irrigation systems to district governments and drastic downsizing of central agency staff, including the transfer of national and provincial civil servants to become employees of district governments. This refutes any hypothesis that major institutional changes in irrigation were politically impossible. Entrenched interests and institutional inertia were overcome. However, this did not take the form of IMT currently popular in international discourse on irrigation reform, but instead were one part of a larger set of reforms in governance which ended up devolving authority down to a lower level of government, but without necessarily strengthening the role of water users in irrigation governance.

Water users have also tended to be relatively unenthusiastic about taking over full control of irrigation systems or subsystems, and relatively accepting of continuing agency roles in water management. While farmers often have complaints about poor

performance, they still see state action in irrigation as legitimate, and attractive in terms of the benefits of state subsidies. This contrasts with the romantic, populist, and localist notions that sometimes seem to underlie policies for increasing participation and reducing passivity attributed to state patronage. Communities are not pressing for the state to withdraw from irrigation or for the state to wither away.

Programs for irrigation management transfer focused heavily on shifting tasks to farmers. Less attention was paid to the tasks that would require continuing cooperation and interaction between government and farmers, such as distribution of water to secondary canals and construction of major repairs and improvements. The rationale for irrigation management transfer was often framed in terms of reducing government expenditures on operation and maintenance by shifting costs to farmers, rather than improving performance in delivering services. Funding was provided for a single round of rehabilitation, as part of turnover. Much less was done to develop capacity for future repairs and improvements. Funds often went to restore irrigation systems to their earlier condition, continuing works that had not been completed earlier, and adding canal lining, without detailed analysis and development of the institutions and infrastructure needed for new management partnerships.

IMT projects are often conceived in terms of having farmers take over responsibility for management the entire irrigation system, or a larger part of it, with an agency delivering water to a canal headgate. However, IMT reforms are often partial and incomplete (Vermillion 1996) resulting in continuing ambiguity and uncertainty about responsibilities. Rather than creating a clean separation of roles, as sometimes suggested by the concept of “wholesaling” water, the result in Indonesia has typically continued to be a combination of cooperation and conflict in managing access to water. Responsibility for maintenance is spread among farmers and different levels of government, in ways that are uncertain and that may discourage preventive maintenance. Major repairs and improvements are still carried out through special-purpose project institutions that are relatively disconnected from farmers and line agencies. This situation creates both problems and opportunities, for agency officials and farmers.

Despite clear doctrines for irrigation water distribution, actual practices commonly reflect a mix of past practices and accommodations to the capacities and constraints of new infrastructure. In particular, water distribution practices often diverge widely from the highly technical procedures for planning and measuring water distribution prescribed by official standards.

The failures of past efforts to transfer irrigation management, the existence of policies for participatory irrigation management, and the continuing need for cooperation between farmers and government in key tasks do create conducive conditions for developing co-management. In Aceh and elsewhere, for medium and large scale irrigation systems, the concept of co-management could provide a useful framework for facilitating joint efforts to improve the flow of information about water needs and adequacy of service delivery, understanding of the potential and constraints for improving irrigation system performance, and organizing cooperative action to make improvements.

Co-management is particularly crucial for situations such as management of larger irrigation systems and provision of government aid for irrigation system repair and

improvement, where cooperation between users and government can be essential for obtaining good results. However, co-management requires not just effective organization, but also adequate infrastructure and operational procedures.

Internationally, experience with participatory governance and co-management, and the difficulties of implementing sharply contractual approaches to devolution have led to what might be called a second generation of ideas about how co-management can be understood and practiced (Carlsson and Berkes 2005). Interactions between agencies and communities are not just a matter of giving stakeholders a voice in agency decisions or devolving management to the “lowest possible level.” Instead, many tasks require joint decisionmaking and dealing with the interaction between different scales, in space and over time. Co-management is a more contested and confused process than that suggested by policies for formal devolution of authority, “wholesaling water,” and service agreements that would attempt to sharply delineate agency and farmer roles.

A more flexible approach to co-management may involve multiple and shifting sets of participants, adaptive decision-making; and evolution in how problems are defined and solutions attempted (Carlsson and Berkes 2005) and this also seems to fit well with conditions in Aceh and many other parts of Indonesia. Co-management is subject to continued contestation, as multiple agencies and levels of government seek to assert or reassert authority, and communities pragmatically produce the appearance of compliance while perpetuating local practices. In Indonesia, the retreat from bolder IMT policy creates the need to more carefully examine the options for crafting better cooperation between water users and irrigation agencies.⁷ In Indonesia and elsewhere, a key challenge seems to lie in the development of more effective approaches to co-management of critical tasks, in ways that support cooperation at multiple scales.

POLYCENTRIC PROBLEM-SOLVING

Lessons from attempts to improve participation in irrigation management help to clarify the potential and constraints for adaptive co-management to solve problems in irrigation water management. The implication of a practical perspective on participation is the need to focus carefully on those forms of cooperation likely to be most feasible and worthwhile for all involved. This does not rule out more drastic institutional restructuring such as IMT if suitable conditions exist to make it feasible, but is intended to highlight the opportunities that may exist where such shifts seem difficult or impossible. These opportunities seem likely to lie in three areas: 1) participatory design; 2) networking among water users; and 3) an adaptive problem-solving approach to improving irrigation systems. In Aceh, as elsewhere, experience has shown the feasibility of involving users in design and construction. Widening linkages between water user organizations is also generally feasible, through the formation of WUA federations. In response to problems and crises in water distribution, co-management may provide a framework for instituting improvements to adapt irrigation operation and maintenance to changing conditions.

Recent projects in Aceh, particularly NSIASP and ETESP have sought to more thoroughly apply participatory approaches to design. This benefits from users' knowledge of local conditions and incentives to provide improved performance. Participation involved a package of institutional arrangements including joint irrigation system walkthroughs to discuss problems and priorities, a series of meetings to discuss

draft designs, strengthening of irrigators' organizations, and involvement of users in carrying out construction, with the process aided by a facilitator of some sort. These approaches drew on ideas initially pioneered in the Philippines and Sri Lanka and subsequently widely emulated in Indonesia and elsewhere. While not always easy to implement, they have generally proved feasible to apply. This experience now provides a repertoire of ideas and procedures that agencies and farmers can draw on in cooperating to solve problems that require repair or improvement of irrigation systems.

Organization of water user associations on a wider scale, as federations at the secondary canal and irrigation system level has also proved feasible in many parts of Indonesia and in other countries. There is also potential for wider networking within watersheds, districts and provinces. While full takeover of management of secondary canals is problematic and may be unlikely to proceed, there is much scope for improving cooperation and performance in main system management. In some cases development of WUA federations has been linked with changes to improve water distribution within irrigation systems, particularly providing more timely delivery, better coordination of cropping schedules, and more equitable sharing with tail-end areas. The most important opportunities for wider scale networking seem to lie in improving the equity of water distribution within irrigation systems and within watersheds. The capacity of bureaucratic management to enforce compliance with water allocation is quite limited, so participatory forums open up the opportunity to mobilize more general support for changes in water distribution.

Recent analysis by proponents of "irrigation modernization" (Renault, Facon and Wahaj 2007) argues that many irrigation systems are inherently difficult or impossible to operate as designed, not only due to deficiencies in infrastructure as actually built and maintained, but also due to inherent complexity in how fluctuations in water flows propagate along canals in response to gate operations, rainfall, changes in water taken by farmers and the nonlinear, ways these factors interact. The argument is that irrigation systems must be understood as complex adaptive systems, which require incremental adjustment, learning and adaptation, for which there is no single or stable solution for water distribution.

Rather than being able to impose a standardized doctrine for water distribution the need is for learning and adaptation customized to local conditions. Various adjustments in infrastructure and operating rules may help to reduce and stabilize fluctuations, but will still require continuing adaptation to changing and unpredictable conditions. This analysis argues that centralized command-and-control methods are inherently incapable of delivering good performance in irrigation management, particularly in run-of-the-river irrigation systems that lack storage reservoirs to buffer fluctuations in water availability and stabilize flows. Analysis of irrigation modernization in terms of management of irrigation as a complex adaptive system clarifies the challenges involved in providing reliable delivery of water to secondary irrigation canals and fields, showing the need for continuing two-way flows of information, adjustment, and learning to adapt irrigation operations to changing conditions. This emphasizes water delivery to secondary canals as a key area where continuing cooperation between farmers and agencies is essential for effective irrigation management.

Sophisticated approaches to irrigation modernization that actively involve users in diagnosis and testing of new operational arrangements have the potential to stimulate fertile forms of co-management. However, there is also a risk that “irrigation modernization” is misunderstood to mean simply the installation of specific infrastructure, particularly long-crested weirs in canals and measuring flumes, along with standardized operational procedures. Furthermore, there is a crucial need to look not just at how to improve the reliability of water delivery to canal headgates, but to improve delivery to tail-end areas. Perpetuating an exclusive division of labor that leaves distribution within tertiary canal areas purely to farmer responsibility would mean being blind to the actual impact on farmers. Without improvement in main canal management, improving water delivery in tertiary areas is often difficult or impossible. However, improvement in delivery to canal headgates is often insufficient to lead to wider and more equitable distribution, and government may have a crucial role to stimulate attention to this level. Therefore, the need is for co-management, rather than an exclusive division of labor between agency and farmers.

Once current water distribution practices are seen as a pragmatic bricolage, blending top-down and bottom-up ideas and institutions, then it becomes easier to see how they provide space for adapting to changing conditions, and for continuing current practices if they do not pose critical problems for performance. Many irrigation systems can deliver water reasonably well most of the time to most users, although there may still be serious problems for those towards the tail-end. The question may not necessarily be one of optimizing ordinary performance, but of what threshold is necessary or sufficient to lead to problem-solving and significant improvement, whether in response to drought, tail-end deprivation, or other problems. In the context of state intervention, it also becomes important to ask to what extent such intervention tries to promote or require changes to pursue objectives such as increased equity, productivity and environmental sustainability.

In Indonesia and elsewhere, it seems likely that future efforts at improving management institutions in larger irrigation systems are likely to be less ambitious and conceptualized in different terms from simply achieving decentralization, devolution, or “transfer.” A key question thus concerns what concepts may be used to frame future projects. Ideas about irrigation modernization offer one candidate approach. Another option is more “business-as-usual” rehabilitation projects to restore infrastructure and perhaps upgrade lining and gates, possibly accompanied by a gloss of superficial institutional reform attempts. Another possibility may be relative neglect or abandonment of irrigation investments (as argued by Frederiksen 2005) with governments reducing budget allocations for irrigation construction and operation. There may be more attention to context specific approaches that seek to avoid the perils of simplistic panaceas (Merrey et al. 2007). The political appeal of aiding farmers and increasing shortages of water seem likely to drive continued government intervention in irrigation, in one form or another. In many countries, rising expectations for democracy, participation, and agency accountability are likely to encourage implementation of participatory approaches, creating conditions conducive for further development of various forms of co-management and the potential for participatory problem-solving.

CONCLUSIONS

Historically, irrigation governance has been organized at multiple levels. Irrigation construction and management often involves cooperation across multiple communities and government involvement. Even in systems that appear highly centralized, substantial scope for local adjustment and contestation has been present. These patterns of polycentric irrigation governance are likely to persist, so that co-management, in one form or another, is likely to continue to be an important part of irrigation management.

Governments in Indonesia and elsewhere can be expected to continue to intervene in irrigation, to secure food supplies, aid rural areas, and respond to increasing water scarcity. Many irrigation systems encompass more than a single community, so some relatively formal governance structures are essential. In this context, decisions will be made about how to manage shared resources. Therefore, attempts at institutional crafting or social engineering may be inevitable. Top-down visions of neatly hierarchical arrangements for water distribution may well continue to appeal. However, practice is likely to continue to be much more complex and contested, creating a polycentric bricolage of improvisation and adaptation. Rather than a triumph of centralization or decentralization, the future may well lie in the middle, in an improvised mixture of social engineering and participatory problem solving.

The 2006 Law on Regional Government for Aceh stipulated that *keujreun blang* would be legally recognized, along with other positions such as *Panglima laut* fisheries leaders. However, the specific mechanisms through which this may occur have not yet been formulated. While there is interest in and concern for encouraging the vitality of local institutions such as *keujreun blang*, there do not yet seem to be proposals for reforms as strong as those embodied in the attempts in West Sumatra to restore the control of traditional *nagari* communities over local land, water and forest resources. Irrigation continues to be an important part of rural livelihoods in Aceh, driving action by farmers and government. Social engineering and participatory problem-solving both seem likely to continue, playing out in the context of episodic mobilization by farmers, bureaucratic bricolage, and contested co-management.

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¹ The author worked as Sociologist and Water User Association Specialist on the Earthquake and Tsunami Emergency Rehabilitation Project in Nanggroe Aceh Darussalam and Nias Island, Sumatra, which was funded by a grant from the Asian Development Bank. He earlier worked on a variety of projects related to participatory irrigation development in Indonesia from 1988 through 2002. Statements in this paper are the views of the author and do not represent those of any organization with which he is or has been affiliated.

² For a recent international review of experience and directions for irrigation development, see the chapters on institutions and on irrigation in the report of the Comprehensive Assessment of Water Management in Agriculture (Molden 2007, Merrey et al. 2007, Faures et al. 2007) and analyses in Mollinga and Bolding 2005 and Shivakoti et al. 2005.

³ What the government invested in Aceh was far less than what it gained in revenues from oil and gas from Aceh, a major point of conflict between those in Aceh and the national government in Jakarta.

⁴ see also Lévi-Strauss' original discussion of bricolage (1966 [1962]) available at <http://varenne.tc.columbia.edu/bib/info/levstcld066savamind.html>

⁵ For a discussion of the turnover project and subsequent attempts at participatory reform, see Bruns 2004.

⁶ General information on the project is available on ADB's website at <http://www.adb.org/Projects/ETESP/default.asp>

⁷ The policy shift was most clearly marked by the 2004 Water Law, which did not provide any explicit support for IMT, which had been enabled by an earlier Government Regulation on Irrigation. Subsequently, the new 2006 Government Regulation on Irrigation reaffirmed government responsibility for managing irrigation systems to the tertiary gate and 50 meters beyond it, while still calling for "participatory irrigation management" but with little detail as to how this would occur.

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