

Tanowong Bwasao Irrigation System, Philippines

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1 Part I: Static Analysis - Collective action

This case covers the Bwasao stream diversion irrigation system (an expansion of the traditional terraced irrigation system; case #38 in SES library) of the Tanowong people who live in the western portion of the Mountain Province in the Northern Luzon highlands of the Philippines, within the municipality of Sagada. The Tanowong people occupy four villages situated at varying altitudes, ranging from the bottom of the mountainside to the summit with a combined population of around 1,000. Despite living in discrete villages, the villagers perceive themselves as a single sociopolitical unit sharing the same Bontoc cultural heritage. This case study is part of the original Common-Pool Resource (CPR) database. The key resources (natural infrastructure) in the Tanowong irrigation system are watershed [e.g. the pine forest] (shared), springs [e.g. local freshwater point] (shared), and Bwasao stream [e.g. source of irrigation water] (shared). The key resource relevant to the commons dilemma faced by the community is irrigation water (common-pool) from local springs and Bwasao stream diversion.

1.1 The Commons Dilemma

The commons dilemma in this system can be divided into two periods: before and after the Bwasao Stream Diversion Project.

Before the Bwasao Stream Diversion Project

- **Potential appropriation / poor coordination of appropriation:** In the preexisting traditional irrigation system, coordinated action was required to ensure the ditches functioned properly and that water was distributed equitably among the Tanowong households. Because the local water sources were limited and subject to seasonal variation, conflicts over access to irrigation water were possible. To prevent disputes, the community institutionalized a water distributor system in which several trusted individuals were appointed to allocate water daily and monitor flows among terraces.
- **Potential under-provisioning of public infrastructure:** Maintenance of the irrigation canal depended entirely on Uyauy, the norm of voluntary collective labor. Every family was expected to contribute labor, and Each *dap-ay* (men's council) was also assigned responsibility for a specific segment of the irrigation network and for organizing its members' labor during regular repair activities, in other words, participation was enforced socially through the *dap-ay*. This division of responsibility allowed the Tanowong to evaluate each *dap-ay*'s performance, identify those that failed to fulfill communal duties, and maintain accountability across the community. Because labor allocation was organized by segment, shirking was visible, and fines or ridicule functioned as deterrents.

After the Bwasao Stream Diversion Project (1954)

- **Potential over appropriation / poor coordination of appropriation:** When the traditional water sources could no longer satisfy the needs of the expanding rice terraces, the Tanowong initiated the Bwasao Stream Diversion Project to tap a more abundant source located deep in the northern pine forest. This expansion, however, created an appropriation conflict between communities: the neighboring Agawa people also claimed historical rights to the same stream. Because property rights to the Bwasao watershed were initially unclear, it was difficult for the Tanowong to exclude other

potential users, even after they had invested heavily in constructing the diversion canal. The absence of formal recognition of exclusive use rights intensified the risk of over-appropriation and inter-village disputes. The Tanowong people faced the challenge of (1) making lobbies to the central government so that they would be given the exclusive formal use right of the Bwasao stream (2) eliminating the threat from the Agawa people by helping them build another physical infrastructure system that could tap into a different water source. Tackling these challenges required a significant amount of soft infrastructure, including: voluntary labor, fees, and investment in social capital with neighboring villages (i.e., intermarriages with the neighboring village, Pedlisan, expanded the sense of community of the Tanowong people outside their physical village).

- **Potential under-provisionings of public infrastructure:** In order to construct the necessary 25 kilometer canal (hard-human infrastructure, “HI”) to bring the Bwasao Stream water, the villagers had to contribute a significant amount of voluntary labor work (soft-human infrastructure “SI”), which functioned well because of the existing dap-ay system (SI), that was developed under the traditional irrigation system, and monetary support from the government (SI). However, there remained a threat of both an internal and external free-rider problem to the hard public infrastructure. Internally, the Bwasao canal (HI) requires regular maintenance and community members generally participate without difficulty and penalties exist for noncompliance. Externally, the Agawa people (who did not contribute to the provision of the hard public infrastructure) tried to claim water rights to the stream after the new canal was built.

1.2 Biophysical Context (IAD)

- **Natural infrastructure:** The Bwasao stream is north of the Tanowong village and maintains a strong, annual flow of water. The location of the Bwasao stream is relatively distant from Tanowong and much closer to the Agawa village, who felt that their proximity to the stream entitled them to it. At the time of the conflict, there were no formal water rights. Application for water rights by the Tanowong people would soon be initiated, but the process of gaining the formal water rights through the local government would take almost two decades. Additionally, two irrigation systems supplement seasonal rainfall to provide continuous water for private, terraced agricultural fields, used for growing both sweet potatoes and rice located on a mountainous sloped terrain. Furthermore, there is also a nearby pine forest, which when dense enough, functions as a watershed for the nearby villages and to external communities is a potential resource to harvest oleoresin. In addition to these irrigation systems, the community also relied on several local springs located closer to the village. These springs provided water for domestic uses such as drinking, washing, and small-scale gardening, but their discharge was limited and highly sensitive to seasonal variation. During dry periods, many of these springs would diminish or dry up completely, further increasing the community’s dependence on rainfall and reinforcing the perceived need for a more reliable external source of water such as the Bwasao stream.
- **Hard human-made infrastructure:** An original traditional irrigation system existed prior to the construction of another supplementary irrigation system, the Bwasao irrigation system, which consists of a dam and 25-kilometer ditches from the Bwasao stream to the Tanowong village. The Bwasao irrigation system was initiated in 1954 and took two years to complete. It was built by the Tanowong villagers and required self-organization of people to provide sufficient labor and supplemental monetary financing from the regional government of Sagada. The system includes dams and wooden flumes that divert and convey water along steep mountain slopes,

and aqueducts crossing multiple streams, reflecting impressive indigenous engineering skills developed through generations of local experience. These infrastructures enable water delivery across rugged terrain to sustain the village's rice terraces, the hard human-made infrastructure, representing not only the primary source of subsistence but also a symbol of social identity and prestige among the Tanowong people.

1.3 Attributes of the Community (IAD)

The Tanowong people occupy four villages: Tanowong (the mother village), Kadatayan, Nadatngan, and Madongo. About 1,000 thousand people lived in these villages around 1980. These four villages are homogenous in terms of culture and sociopolitical regime. Although living in discrete villages, the people perceived themselves as a single sociopolitical group separate and distinct from their neighbors and there is much coordination in the social, religious, and political affairs.

The community is characterized by an egalitarian social structure, in which nearly every household owns at least one rice terrace and all members of the family participate in cultivation and maintenance activities. The rice terrace serves not only as a means of subsistence but also as a badge of citizenship, symbolizing membership, status, and moral obligation within the community. In contrast, crops such as sweet potatoes are considered supplementary, lacking the same cultural significance. The dap-ay system, composed of councils of elder men, stands at the core of community governance. Beyond decision-making, each dap-ay functions as a moral and ritual institution that legitimizes rules, conducts ceremonies, and sustains social cohesion. Rituals associated with the spirit of water reinforce both spiritual beliefs and practical norms for resource management, integrating religion and environmental stewardship. The community also maintains strong kinship and intermarriage ties with neighboring villages, particularly Pedlisan, which facilitate co-ownership of terraces and reciprocal labor exchanges. Such kinship networks and shared moral norms generate a high level of trust, reciprocity, and collective identity, forming the social foundation that enables effective self-organization and long-term maintenance of the irrigation systems.

• Social Infrastructure:

- **Identifying resource users and public infrastructure providers:** The water resource users in this system are the Tanowong people, while the public infrastructure providers include: (1) the dap-ay institutions that organize labor and make decisions on water management; (2) the regional and national government that provide funding and formal water rights; and (3) local political representative who lobby for government support.

- **Description of dap-ay:** The Tanowong are organized into four dap-ay groups, each comprising about thirty families. These serve as the social, political, and ritual centers of community life, where decisions regarding irrigation systems (e.g., labor allocation, fee collection, building a new physical infrastructure, etc.) are made collectively. Beyond governance, the dap-ay functions as a moral institution that legitimizes local rules and sustains social cohesion through shared norms and rituals

- **Trust and solidarity within the community:** There is explicit competition and coordination between the dap-ay, described as a "loyal opposition" that strengthens unity. There is no known case of anyone being fined or punished for outright refusal to cooperate on the Bwasao irrigation project (including: building the dam, ditch and maintenance). Instead, there has been eager support from the community to initially build the hard public infrastructure; work crews were composed of villagers from both sexes and all ages, led by the old men. There was a strong feeling of common purpose and solidarity among the

Tanowong people as a result of the Bwasao project, that still prevailed in 1972. The irrigation system is a source of strong social cohesion among villagers, in that it provides the entire community with a central issue with which all members identify strongly with and can be a focal point during times of external conflict.

- **Inter-village Social Networks and External Linkages:** Intermarriage and cooperative ties with the neighboring Pedlisan village expanded the community's social network, while rituals honoring the spirit of water reinforced moral obligation and environmental responsibility. Limited government assistance also introduced new, though modest, trust links between the Tanowong and external institutions. For instance, funds from the government to assist with the Bwasao project garnered a new consciousness and favorable attitude toward the normally remote national government.

• **Human Infrastructure:**

- **Experience/skills:** Because of the new project to bring water from the Bwasao Stream, villagers gained a new dimension of experience and education in leadership, particularly in the skills of negotiation with other villages and in dealing with a modern government bureaucracy. All of the formal and informal negotiations which the Tanowong undertook with the opposing village of Agawa, with her close neighbor of Pedlisan, and with the various government officials and agencies of the national government have been fertile fields of social and political experience for the villagers. This was especially true for the community leaders, who learned to deal with a much wider universe than the village and were able to progressively build skills and confidence in coping with internal and external challenges.

- **Knowledge:** Often each dap-ay is assigned responsibility for specific segments of regular projects like trail and irrigation repair. In such a case, year in and year out, the members of each dap-ay know exactly where to go at the appointed day or days of work. The Tanowong people were able to construct the dam in Bwasao and a ditch from it to their village even with no sophisticated surveying equipment. This remarkable engineering feat was made possible only through their indigenous knowledge from their detailed familiarity with the territory from years of hunting and foraging. In the spring of 1972 the people of Tanowong and Pedlisan united strongly in opposition to the owners of a paint manufacturing firm in Manila who wanted to gain concessions to tap for oleoresin in the local pine forests. This opposition to the exploitation of the pine forest resources is due to the realization of the correlation between the density of trees and the amount of available water.

1.4 Rules in Use (IAD)


- **Position Rules:** There are four explicit positions mentioned in the research: 1) Water users 2) Dap-ay, 3) Water distributor, and 4) Village officials
 1. **Water users (households / farmers):** Water users provide maintenance assistance for the canal to maintain water flow for all water users. The responsibility for maintenance rotates among water users and is communal during the dry season. From the start of the rainy season until the next season, irrigation is individualistic and not communal.
 2. **Dap-ay:** The dap-ay are the key decision makers and decide how to implement decisions, such as how to collect materials or money, how to distribute labor for community trail and irrigation repairs, and also disseminate information throughout the village. The dap-ay divides the distribution of goods, money, or labor among its families and enforces their delivery. The dap-ay are also in charge of negotiation with other villages and the government.
 3. **Water distributors:** There are eight to twelve water distributors who govern

the flow of water from the canal to different fields, as necessary.

4. **Village officials:** Village officials act as intermediaries that link the Tanowong community with external institutions such as the Philippine government and regional administrative agencies.
- **Boundary Rules:** Each member of the community can be a water user and can also assume the sub- position of repair crew-member, depending on physical capabilities. The research does not describe the selection process of or requirements of the dap-ay. The water distributors are informally selected by the people based on dependability, diligence, and fairness. Water distributors who are uncooperative or engage in misconduct may be replaced through collective community consensus. While it is not explicit that females cannot assume the role of dap-ay or water distributor, there is no mention of a female holding this role.
 - **Choice Rules:** Every water user must contribute to the public infrastructure maintenance such as annual ditch repair. Water users may withdraw water from the system but must not withdraw more than what is assigned to them by the water distributors. The water distributors must ensure fair allocation of water to the private terraces and inspect for leaks. . When there is unusual heavy damage to a segment, such as a massive landslide, all villagers must help out with repair efforts, unless they are physically incapable. While not explicit that all water users must grow rice, traditionally each family has owned at least one rice field and payment to water distributors is made in rice after harvest. Elder men may call meetings, adjust labor assignments, impose fines.
 - **Aggregation Rules:** Community problems are discussed in individual dap-ay gatherings as well as village-wide meetings. Every mature man participates in the deliberations of the council. Water distribution problems are resolved by the water distributors. Tanowong and Pedlisan call joint meetings for inter coordination. Major external agreements, such as formal water rights, require approval by Barangay officials and the Philippines national agency.
 - **Scope rules:** It seems that there are no clear rules of who can appropriate water in the system, neither are their clear physical boundaries of the system. Regular maintenance ensures that all terraces receive adequate water. Free riders, who fail to participate in shared labor are fined in the form of money (one peso), rice, or a good drink and meal for the group. Forest degradation is recognized as a threat to water availability, linking environmental management with irrigation outcomes.
 - **Information Rules:** Dap-ay groups exchange information during meetings, including schedules for communal work and decisions on maintenance. The water distributors have to go to the top of the mountain to overlook the terraces and exchange information of which part of the area will need water the most that evening. Any Tanowong villager can report violations of a dap-ay's civic duties, if they witness it.
 - **Payoff Rules:** Men from the village collect fines from those who fail to participate in repairing ditches during the communal repair season. The fines take several forms: money (one peso), rice (fine bundles), or a good drink and meal for the group. Lazy dap-ay members are socially ridiculed rather than formally punished. Water distributors are paid at the end of each harvest by receiving 5 percent of the total harvest.

1.5 Summary

Originally, the Tanowong irrigation system worked as an independent but stable local institution, supported by strong social ties and clear customary rules. When water became scarce, however, the limits of this self-sufficient system became clear, and the community



had to face new challenges from outside. To secure a more reliable water source, the villagers built the Bwasao diversion, which brought both conflict and learning that conflict with the neighboring Agawa people and learning through negotiation and interaction with external actors. Through this process, Tanowong changed from a community that looked inward to one that could cooperate and communicate beyond its boundaries, building formal relationships with the government and nearby villages. This experience shows how a once isolated but well-organized system was able to adapt to outside pressures by forming new connections and increasing its ability to endure future challenges.

2 Part II. Dynamic Analysis - Robustness

This update to the Tanowong irrigation system is based on an interview with the author of the original source document in 2011 specifically addressing ongoing changes in the study area.

2.1 Update on the Commons Dilemma

While the original threat of new users (the Awaga) to the Bwasao stream was overcome by the skillful negotiation of the dap-ay and the community effort of all water users, new threats to water rights over the Bwasao stream are surfacing. Currently, in the nearby region of Sagada, populations are steadily increasing and so is the demand for water. The government officials in Sagada have been looking to the Bwasao stream as a potential water resource for their increasing needs. The current commons dilemma for Tanowong lies between preserving its autonomy in water management and accepting government financial assistance, which could ease the burden of maintaining the irrigation system but might also compromise local control.

2.2 Shocks, Capacities, Vulnerabilities

- **Link 1 between R & RU** : Water availability from the Bwasao stream and other local sources sustains rice cultivation, which holds deep cultural and ritual significance for the Tanowong people. The reliability of this resource directly supports their subsistence and reinforces their cultural identity through annual rice-related ceremonies. Farmers extract water from the Bwasao and nearby springs to irrigate rice terraces and other crops, while villagers also depend on the surrounding pine forest for hunting, gathering, and collecting forest products that support their livelihoods.
- **Link 1 between R & RU (capacities)**: The Tanowong people (RU) recognized the water shortage for rice terraces and came up with the idea of tapping the Bwasao stream (R) as a new source of water. The Tanowong people were familiar with Bwasao stream because it lies within their hunting and gathering range; they knew the stream had a strong annual flow. Because this resource is steady and dependable, additional villagers have tried to become resource users of the stream; this has created tension between the Tanowong people and external villages who compete for the resource.
- **Link 2 between PIP (government) & RU**: The Bwasao irrigation expansion heightened the awareness of the Tanowong people (RU) of the national government (PIP) system as a source of financial, material, and technical aid. Earlier experience with the government was often negative, in that the government demanded taxes and free labor for roads and other kinds of construction, and demonstrated its power through incarceration of individuals in prisons. For a relatively isolated minority group, this positive development is of critical importance in furthering Tanowong's identification with and integration into the national political system.
- **Link 3 between PI (water rights) & PIP (government)**: In the course of placating the water conflict with Agawa, the Tanowong people became convinced of the necessity of obtaining government (PIP) sanction for their irrigation system as a means of ensuring permanent control of the water source to future potential encroachments. An application to the government for a water right, accompanied by a petition from the community, was filed early in 1956 to initiate the proceedings. In April 1972, the Tanowong village was granted a temporary water right (PI) certificate by the secretary of the Department of Agriculture and Natural Resources.
- **Link 3 between PIP & PI (dap-ay)**: The traditional Tanowong irrigation system had existing social organization in the form of the dap-ay system; this system proved

adequate for the construction and continuing maintenance of the Bwasao irrigation system. The Bwasao ditch is repaired annually every January. Different dap-ay are assigned specific segments of the ditch as their maintenance responsibility. As soon as the water is safely flowing through the ditch beginning from the Bwasao dam, the water distributors take over as in the pre-existing irrigation system.

- **Link 3 between PIP (congressman) & PI:** A Congressman (PIP) supported the Tanowong's Bwasao irrigation project with his discretionary development funds ("pork barrel" funds) following his election to office. These funds supplied additional labor needed to complete the irrigation work. After these government funds were expended, subsequent grants were obtained from the government for further work on the irrigation system (PI) for widening and straightening its course.
- **Link 3 between PIP (villagers & government) & PI (communal forest):** Co-operation efforts between Tanowong (PIP) and Pedlisan (PIP) succeeded in protecting their pine forests from a paint manufacturing firm (competing RU). As a result there is a strong movement to have the surrounding forest areas declared a watershed or communal forest (PI) by the government (PIP), which would make them immune to outside exploitation for lumber or oleoresin.
- **Link 4 between PI & Resource (R) dynamics:** Forest degradation reduces water supply from the watershed and increases maintenance burden of irrigation canals. The canal and dam improve the reliability of water delivery from the Bwasao to the rice terraces. Local rules and cooperation promote responsible water use and regular maintenance. Tanowong and Pedlisan are very similar culturally, closely situated, and traditionally friendly due to both intermarriages and shared territory (shared territories are a positive feedback of intermarriages). These factors result in them sharing water resources. Their established social capital played a critical role in preventing a paint manufacturing firm (RU) from gaining concessions to tap for oleoresin in the pine forests (R) whose function is to keep available water
- **Link 5 between 1 & PIP:** Water distributors monitor daily water use and system conditions. Village leaders (dap-ay elders) impose fines on resource users who fail to participate in do not contribute to infrastructure maintenance. Distributors help prevent conflicts between villages by ensuring fair water allocation. Soft infrastructure (rules, monitoring, enforcement) and hard infrastructure (canal, dam) jointly sustain reliable water delivery and long-term watershed stability
- **Link 6 between RU & PI (vulnerabilities):** Unclear water rights create tension among potential users. No sooner had the Tanowong (RU) begun work on their expanded irrigation project than another village, Agawa of Besao municipality, asserted claim to the water resource. After much negotiation between the leaders of Tanowong and Agawa, the Agawa people reluctantly agreed not to interfere further with the Tanowong project from 1954 to 1955. However, in 1970 the Agawa people tried to tap one of the springs above the Tanowong dam at Bwasao, relying on their previous claim that if at any time in the future Agawa should need water, the Tanowong were to share some with them. The Tanowong people were so upset that they let their determination be known to fight any incursion of their water resources. But their new negotiation was achieved with the help of the increasing number of intermarriages and the resulting joint ownership of rice fields: 1) The Tanowong people proposed that the Agawa tap another stream in the vicinity; 2) The Agawa argued that they would accept the Tanowong proposal if the Tanowong people would carry and install the pipes from the proposed water source toward the Besao municipal center; and 3) the Tanowong people finally agreed in order to eliminate the Agawa threat to their water source. In recent decades, however, population growth in the nearby Sagada municipality has renewed external pressure on the Bwasao

- stream, posing a new modern form of vulnerability.
- **Link 7 to R (shock):** Forest degradation caused by logging and recurring fires reduces overall water yield from the watershed. The loss of tree cover increases runoff variability and lowers dry-season baseflow, weakening the reliability of irrigation water supply. Growing internal and external populations create shocks to the water resource in the form of increased demand. Internal pressures may include: (1) the expansion and increase in the number of terraces on the original site, (2) the construction of new terraces along and below the irrigation ditch which necessarily diverted water permanently, and (3) the denuding through careless cutting and frequent fires of the pine forest of the mountains in the environs of the streams which served as the source of irrigation water.
 - **Link 8 to RU & PIP (shock):** The neighboring Agawa people threaten the Tanawong access to RS. Rising urban water demand from Sagada introduces new external competition for the resource. Decline of traditional communal labor participation due to the introduction of paid government labor programs. Urbanization has led many capable community leaders to leave the village for better opportunities, weakening local governance capacity

2.2 Robustness summary

Internal shocks to the water resource occurred in response to the Tanowong people's increasing demands for agriculture (link 7 to R). While switching some agriculture from rice to sweet potatoes helped conserve water, rice is still grown as it is part of the Tanowong's cultural heritage (link 1 between R & RU). The Tanowong people have abundant indigenous knowledge of the Bwasao stream and its yield (link 1 between R & RU). The traditional social organization and pattern of maintenance established for the pre-existing irrigated terrace system (see case #38) proved adequate for managing the dam and ditches from the Bwasao stream to the Tanowong village (link 3 between PIP & PI). Financial support came from the local government and a local Congressman (link 3 between PIP & PI). The Tanowong people were concerned about future resource users who might try to lay claim to the Bwasao irrigation system (i.e., Agawa village and villages in Sagada) (link 6 between RU & PI). Therefore, the Tanowong people applied for an official water right to the Bwasao stream and were granted a temporary water right certificate in 1972 by the secretary of the Department of Agriculture and Natural Resources (link 2 between PIP & RU). Also, cooperation between Tanowong and Pedlisan succeeded in protecting their pine forests from a paint manufacturing firm. As a result there is a strong movement to have the surrounding forest areas declared a watershed or communal forest by the government, which would make them immune to outside exploitation for lumber or oleoresin (link 3 between PIP & PI). The Bwasao irrigation expansion heightened the awareness of the Tanowong people of the national government system as a source of financial, material, and technical aid. This positive development is of critical importance in furthering Tanowong's identification with and integration into the national political system (link 2 between PIP & RU). To this day, competing interests from the people in the region of Sagada threaten the Tanowong's use of the Bwasao stream.



3. Part III. Case Contributor

Heather Turrentine, School of Sustainability, Arizona State University
Shui Yan Tang, University of Southern California
(case #38)

Cathy Rubinos, School of Sustainability, Arizona State University (case #38)

Hoon C. Shin, School of Human Evolution and Social Change, Arizona State University (case #38)

Kyungmin Kim, School of Sustainable Engineering and the Built Environment, Arizona State University (case #38)