Ecological Wisdom in Irrigation Areas in the Highlands of West Sumatra

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Abstract

Viewed from the field of engineering, major problem in the utilization of water resources for agriculture arises from the fact that the water is very limited by time, place, quality and quantity. In the sphere of agriculture, water saving irrigation is part of the way of civilizing society behavior, to increase productivity and irrigation water usage. Ecological challenges in hills is a major problem in rice field with water, because the slope condition is high enough, then the distribution of irrigation water is not easy to do in a fair and equitable way. But by looking at technological tool for water locally known as "Paraku", which is generally operated in hilly area, this potential challenge is able to overcome. This paper has discussed the development of thinking and describing some of the experiences of local wisdom of West Sumatra, especially in the hills, in an effort to increase utilization of sustainable water resources. From this description can be drawn in concrete some of the learning benefits associated with sustainability of water resources particularly in terms of: (a) information about how water resource management is traditionally held on the hills (Upland area); (b) ideas about environmental conditions affecting the management mechanism and utilization of water resources by farmers, and (c) the ideas about the environmental conditions that can be adjusted *(adjustment)* to streamline the management of water resources by farmers.

A. Introduction

Viewed from the field of engineering, major problem in the utilization of water resources for agriculture arises from the fact that the water is very limited by time, place, quality and quantity. Water originating from rainfall in the region of Indonesia that has wet tropical monsoon climate, with the amount of rain per year is relatively fixed. However, the nature of rainfall in the form of heavy rain during rain events per season is very diverse; even in the rainy season often *dry spell* (the period of no rain in the rainy season) until the decade era.

Weather conditions like this, will affect the growth and yield of crop production (especially for seasonal crops). Even frequent crop failures due to drought. Moreover, frequent rainfall concentrates in a short time, has a high intensity; (and sometimes the shape of the storm) and the potential for the erosion (Hudson, 1959; Mohr, 1972; Williams, 1970; Jackson, 1977 and Pusposutardjo 1993).

The movement of water saving is important, not only in rhetoric. Water-saving criteria identified in terms of efficiency means that, technically, showing the inflow and outflow processes, and generally that refer to water loss in distribution to water use. In the sphere of agriculture, water saving irrigation is part of the way of civilizing society behavior, to increase productivity and irrigation water usage, to allocate it to productive agricultural business objectives by taking into account the welfare aspects of peasant communities, ensure the water needs of a fair and equitable as well as maintaining the carrying capacity of sustainable water resources and sustainable (Gany, 1995).

The paradigma of water resource development that emerges at this time tends to emphasize on sustainable development that can meet present necessities, without sacrificing the ability of future generations to meet their needs in water. In this context, the need to change the managers and users attitudes of irrigation water toward the development of water system value, which is based on principles of efficiency and fairness. Efficiency of irrigation water in paddy field is limited by the needs and limitations of natural resources, especially water.

While when it is viewed from the efforts of management and utilization of water resources done at present, it generally only refers to efforts in reducing loss of water and setting the optimal water delivery, adapted to the needs of water for plant growth and cropping settings relating to climate.

How to divide flattened water to every field often forgotten, although this is precisely one of the fundamental concept of sustainability of water resources hold on four principles namely;

1. The principle of efficiency in the utilization of water resources do not go overboard until the carrying capacity threshold and also not to not utilized.
2. The principle of sufficiency in resource use must be up to the limits of use (not redundant)
3. The principle of consistency in terms of systems of systems must be in harmony with each other and with the wider system.
4. The principle of prudence, it is summarized in the Rio declaration of 15 principles in every activity that is resource use should not damage the ecosystem.

Efficiency of water use in relation to the sustainability of the benefits of water resources, the traditional irrigation is often not inferior when it is compared with irrigation built by the government. This can be seen in some cases in West Sumatra, for example, the area around of Merapi and Sago Mount has developed a system for the water to rice fields with benchmarks as fair and equitable land area processed. In the system in use tool for water called *"Kalimbatang"*, or *"paraku"*. On the island of Bali this technology known as *"tembuku"* or *"pemaroan"*, in Java are usually referred to as *"cowal"* in West Java and *"penaro* "South Sumatra. According to Ambler in 1989, this tool is also found in the Pakistan area called" *choukhat* ", in Nepal called" *saacho* ", in Sri Lanka called the" *karahankota* "and in Thailand they are called by the name" *tai nam nam* ataau *Kiang* ".

Ecological challenges in hills is a major problem in rice field with water, because the slope condition is high enough, then the distribution of irrigation water is not easy to do in a fair and equitable way. But by looking at technological tool for water locally known as "Paraku", which is generally operated in hilly area, this potential challenge is able to overcome.

The question is whether this local technology system (a tool for irrigation water) and water management system behind this system was quite efficient, equitable and economic in water usage. To answer these questions, it has been conducted research on the principles, operating procedures and maintenance of irrigation systems implemented by Paraku by the writer and the team of Irrigation Study Center of Land and Water Resource Development of Andalas University (PSI-SDALP Unand). The results of these studies can be a consideration in irrigation development in the future by marrying the principles of local technology with modern technology of Irrigation.

B. **Development of Ideas In The Event of The Utilization of Water Resources Sustainable, Efficient, Fair and Save**

Prior to this concept that talks about, it should have been uniformed in meaning of water resources.According **to** terminology, water resources which are standard in Law No. 7 / 2004 concerning Water Resource Ps. 1 item 1, is (quote):

"Water resources are water, water sources, and water resources contained in it."

While the water source is defined as (quote Ps. 1 point 5):

"Source water is the place or the natural water containers and / or made available in, above, or below the surface".

Water resources in Ps. 1 point 6 is defined as (quote):

"The power of water is the potential of water contained in the water and / or on the water source that can provide benefits or disadvantages for human life and livelihoods and the environment."

Furthermore, according to Pusposutardjo (2005), understanding more about the terminology that is used in SDA Law No. 7 / 2004 Ps. 1 items 1, cast doubt on a deal of meaning in general sense. Doubt is due to, the meaning of Water Resources (SDA) of Law No. 7 / 2004 Ps. 1 point 1 differs from the meaning of *water resources* is translated as water resources.

In addition to being a mass-energy with the physical properties possessed chemical, water resources must also be interpreted based on the meaning or usefulness to the overall mass of the water of life (Zimmerman *in* 1980 Zein, Pusposutardjo 1997). In accordance with the definition of water resources is the production of water resources according to economic approximation is all forms of activities that aim to convert the water resources of a particular shape and location to be more useful for many purposes the production and consumption further. So, the water will be more meaningful as resources when being in a location has a value of certain benefits in accordance with the needs of the community in these locations (1970:89 *in* Pusposutardjo Dorfman 1997).

Understanding the meaning of water resources is the value of water resources which consists of intrinsic value, which is an intrinsic value and can not be changed, and the utilitarian value of the dynamic nature and relative usage. The value of sustainable utilization is limited by the lower threshold of benefit from the conservative use and the threshold for benefit from the preservative use (Pusposutardjo 1997; 1998).

After understanding the meaning of water resources, it results on conclusion that some previous studies have accommodated the dynamic nature of the value of a resource. Like many of the highlighted (Pasandaran, 1995; Handoko, 1995; Sinulingga, 1995; Illich, 1996; Dumairy, 1992; and Nobe & Sampath 1986). There are some trends shown by these writings:

First that the utilization of irrigation water management approaches need to pay attention and plant growth phase, the capacity of the soil and climatic elements of the other as a determinant evapo-transpiration and rain.

In this connection there are some things that need to be an attention of:

1. In terms of management approach to water use management combinations (*"demand management")* and management of water supply (*"supply management") (Pasandaran*, 1995).

Technically, water management approach *"fever management"* to note is, the schedule of planting, planting patterns and adequate selection of varieties in response to water shortages. The water supply management approach to *"supply management"* among other improvements include provision of water ways, water using ground as channel, the making of Embung technology, all of which bases on; (1) the principles of efficiency, (2) the principle of justice, (3) the principle of participation, and (4) the principle of sustainability[2]

2. In terms of agronomic focus is getting the balance between water supply and the vegetative phase generative phase (Handoko, 1995).

The use of high water can be bad for the seed filling phase, whereas excessive fertilizer can increase vegetative growth. So, in this connection to note the interaction between the factors of plants, soil and climatic elements so that other can be determined by optimum utilization of water. In anticipation to drought, can be performed to determine the schedule of planting and distinguish between the dry season and rainy season in relation to the period of plant growth.

Second, that for sustainable water management needs to available information and the way the regular provision of water with institutional support.

Some things that are relevant in this connection are:

1. Need to be done inventorying process of irrigation areas which have good water security in the rainy and dry seasons. In this way during the preparation of the soil and the critical periods of crop growth cycle, especially the generative, so that an optimum water availability can be achieved (Sinulingga, 1995).

2. Please note how the provision of water for the plants under conditions of water supply and drainage are controlled through: (1) determining the planting schedules; (2) planting pattern; (3) manage water distribution in a fair and equitable; (4) improve the efficiency of water users, and (5) organization of farmers' water users.

3. Minimize the supply deficit which includes; (i) reducing the deficit of water in dry season; (ii) balancing irrigation water deficit in the whole system of truth, (iii) minimizing the overload system during wet periods or seasons.

Third, in the utilization of water resources needs to be done through inter-disciplinary approach as a unit called

[2] The efficiency principle here would be seen tie technical efficiency, as well as economic.Technically, the efficiency of water allocation patterns will be assessed by seeing how much water the river can meet the water needs, is economically efficient allocation pattern will be seen from the value of water to be realized by the river wialayah than actual potentially realized.While fairly, associated with pleasure and a sense of justice to which the value of water can be enjoyed by users of water. The next principle of participation is defined here as the active involvement in decision making. And sustainability in water management means having a pretty good value and durable. (Osmet, 1996)

"Hidronomika" (Dumairy, 1992). There are two things to note in this regard

1. Aspects of natural science and social as covering; (1) Hydrology[3;] (2) engineering; (3) Economics; (4) Agricultural Technology; (5) Ecology; (6) Meteorology; and (7) Sociology. Basic principle here is the need for inter-disciplinary perspective in dealing with water resource management.
2. Principles of water resources management are efforts to balance demanding side (socioeconomic dimension) with offering side (technical / physical environment and climate dimension).

Nobe and Sampath (1986) argue that, it relates to "orchestrating physical and biological resources by using the skills of various disciplines in bringing water to root of plants' zone in order to improve food and fiber production for all classes of farmers".

Fourth, the availability of water resources can also affect the continuing process of water consumption and management activities beyond irrigation management (Osmet, 1995).

Irrigation management activities might be managed to bring water into the root zone, but the activity at the growth stage settings is management activities as well. Thus, understanding the management of water resources for the continuing of agricultural support requires a thorough understanding ranging from water resource management at the river level to the level of water management Farmers (*"farm management")*. Activities outside the water resource management are relevant emphasis on efforts to meet the objectives of the society itself associated with, efficiency, justice, employment and regional economic development, and improvement in maintenance of environmental quality and sustainability (Osmet, 1996:208).

In irrigation water management, an effort to optimize sustainable water resources like the above approach actually has been done in various situations. In the following section presented several cases, ecological wisdom, local society experience in water resource management of sustainable, efficient, equitable and efficient water cultured.

C. Experiences in West Sumatra.

There are several studies related to optimization of water issues in West Sumatra[4] under conditions of less water availability along the river. Results - results of research already carried out the implication that the development of irrigation networks can be seen from the context of river basin as a whole, because the development of a network will affect the availability of irrigation water from other irrigation network along the river stream (Helmi, 1990).

Next, Helmi and Ambler (1990) proposed three possibilities that can be done in the distribution of water between the irrigation system along the river in an attempt to optimize or balance the access to water from the source (irrigation networks between upstream and downstream areas) or within the system itself. The possibility of do these are: (1) increasing the availability of water at the core source, (2) Set a schedule and different cropping patterns in areas along the river basin, and (3) improve the efficiency of water distribution in each irrigation system. **The first** possibility seems to be more difficult to be due to the limited availability of water at the source (river) and it depends on the state forest or conservation land, will be attempted if it will take a long and substantial costs. The **second** possibility with respect to setting a schedule and planting pattern, this possibility seems is one option to reduce the pressure of water shortage, because each region will

[3] Hydrological aspects, namely the science of examining the issues inundated keteknisan which is the basis of quantitative analysis of water supply for development projects of water resources.

[4] a. D. Zein, dkk1986. "Management of Minor Irrigation in West Sumatra: Regional Comparison of Wet, Medium and Dry Flow Regional Batang Tampo / Selo, Tanah Datar, Subdin West Sumatra Province Water Resources and University of Newcastle.
b. John S. Ambler, 1989. "Indigenous and Aid: Management of Small-scale Irrigation in West Sumatra, Indonesia", Cornell University dissertation.
c. Helmi, et al 1991.Pilot Project Management Coordination Inter-Regional Water Irrigation in the Irrigation Branch of Public Works Department Batusangkar, West Sumatra, Ditgasi I, the Director General of Water Resources Department of Public Works and PSI Andalas University.

have adequate water at different times. The **third** possibility, the level of irrigation systems should also consider the water distribution system in an optimal fashion, by seeking efficiency of irrigation water by dividing the fair and thrifty. In understanding the division of water in this way required socioengineering views concerning all aspects of the operation and maintenance, ranging from manpower mobilization, conflict prevention in infrastructure and the distribution of water.

Of traditional irrigation research experience in West Sumatra, the exact use of traditional technology called *"Paraku"*[5], the possibilities mentioned above seem to be implemented. The study showed that *"paraku"* is one tool for efficient water and can share water equitably. The results of field observations showed that for the achievement of agricultural land productivity is not simply a technical activity, but also intersects with human behavior (farmers' organizations) in order to use the right amount of water and time. Organization of farmers is important to conduct a series of activities involving all aspects of operations and maintenance, from the mobilization of manpower, infrastructure and handling of conflicts, especially in the distribution of water (Ekaputra, 1997).

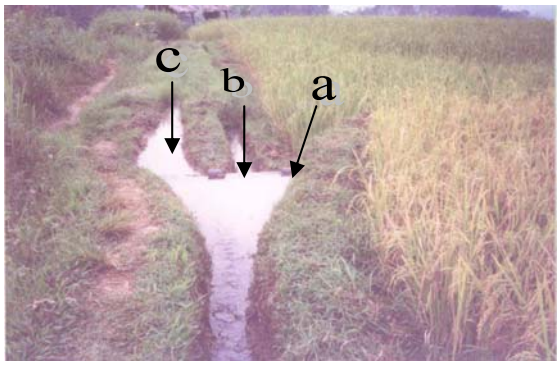

Figure 1. Equipment for paraku a; a part for the rice field, b; part of the map the fields below, and c;is the main channel


Figure 2. the same as figure 1 but a tool for this has been paraku made of concrete.

Judging from the performance of the traditional irrigation system, a tool for value *paraku* has a very high control on the condition that water availability is very limited and fluctuating. This technology helps in preventing farmers for water blockade exaggerated resulting in odd water distribution . The research that was mentioned earlier (Ekaputra, 1997), shows that each farmer has their own channel by channel density range 200 m / ha to 300 m / ha, much higher that recommended by the ICID *(International Commission on Irrigation and Dranage)*is 50 m / ha. With such technology, planting intensity diareal can be done simultaneously, the region upstream, middle and downstream with the intensity of planting between 2 times a year to 5 times in two years. In other words, planting intensity coefficient reaches 2 to 2.5.

Paraku is only a water distribution device that is placed in the branches of the channel. Irrigation water used by farmers who *paraku* regulated in accordance with the proportion of *takuak* agreed and then always confirmed through consultation of farmers led by *Tuo Banda* (airport management). Takuak width may not be altered, except for collective decision through deliberation farmers.

As an illustration, it can be taken from Situgar Irrigation Area case. In this irrigated *area*, *Tuo Banda* is the chiefs or headman of a tribe which has acreage in the irrigation area in question. *Banda Tuo* this function is to make policy on the management of irrigation networks and utilization of rice as planting schedule, the division of water, replacement of equipment *"paraku"* which has been damaged and conflict resolution.

Surveillance of water distribution (through *paraku)* conducted by the *Siak Banda*. This *Siak banda* is appointed through consultation with

[5] Erigas "Efforts to Improve Irrigation Water Distribution Efisieni, Possible Use of Paraku In Broader Scale. Vision irrigation Indonesia Vol 13 1997.

members of the selection[6]. *Siak Banda* was usually one farmer who was elected in the consideration he has a very high importance to the sustainability of irrigation and particularly the function of *paraku.* The main criteria of this are to have the largest area and located in the downstream portion. Hopefully with these criteria, *Siak Banda* was elected will have more motivation to perform its function. Siak banda replacement scheduled for each meeting of farmers after the harvest. The duties and obligations of *Siak Banda* is to provide water from its source to the area of rice fields by the time it takes and take care of the channel and *"paraku"*. *Siak Banda* also set when the water flows continuously and when water is stopped, such as the fields of water treatment is given continuously, whereas in the *rainy* season *Siak Banda* closed channels to avoid a flood or flooding that would damage the irrigation network and a tool for *"paraku"*. If severe damage to the irrigation network , *Siak Banda* must report it to the *Tuo Banda,* and the report *Tuo Banda* mobilize farmers work together to fix it.

For his work, *Siak Banda* gets reward. Great remuneration determined in consultation farmers. Compensation is collected directly from farmers. Each farmer pays a certain amounts; it could be in the form of rice, a proportional amount of the total area under rice that is irrigated by irrigation concerned. Size to determine broad field based on the number of seeds are generally used.

All agreements are generated through farmer consultation and automatically become the order must be obeyed. Apparently, the rules regarding *Paraku* is always emphasized at the beginning of the planting season and followed that farmers tend to act as a powerful oath that reads *"Takuak tetap paraku balumuik"* which in this case means that the tools for *"paraku"* can not be changed especially without the approval of *Banda* or *Ninik Tuo* or *Mamak.* If there is a collision, the person who does this collision imposed by magic spell of *"bapucuak Indak ateh ka, ka under Indak baurek, digiriak Tangah ditangah-beetle"* is meant to Top no bud, no deep down the middle and eat the beetle pests in terms of people who violate the no longer considered socially society.

From the conditions described above *"paraku"* is the realization of local knowledge, which is conditioned to the physical-technical and social local institutions can be judged from the aspect of optimizing the utilization of irrigation water at a sufficient level of optimal. This is shown by the principle of proportion between the width of the door with the water service area, and irrigation performance is sufficient. The Research of Eri Gas (1997) showed that the width of the water threshold at which paraku has a linear relationship with its service area (correlation coefficient value = 0.99). This means that means for a tool of Paraku which takes into account justice and equity and optimization of water use. In other words a tool for *"paraku"* has been able to serve as a means of controlling various environmental variables to the achievement of irrigation[7] optimization value of the use of in the utilization of water resources. Besides, this technology requires only a minimal operating cost[8]

Thus, a tool for water systems *"paraku"* have contributed to the development of problem solving, especially in the field of irrigation, especially with the finding of irrigation water management strategy by using technology as a tool for saving water, which may fit with the environment as in the hills of West Sumatra.

From experience with water resource management system 'Paraku "in West Sumatra, is suitable to support the agricultural system of SRI*(System of Rice Intensification)* in which, the provision of water at SRI farming systems are not pooled, but until *macak-macak* or wet limit, so the irrigation system needed is intermittent irrigation *(intermittent irrigation).* Under these circumstances the irrigation system of "*Paraku*" easily controlled and controlled in every building for him.

D. Closing Note and Future Implication

This paper has discussed the development of thinking and describing some of the experiences of local wisdom of West Sumatra, especially in the hills, in an effort to increase utilization of sustainable water resources. From this description can be drawn in concrete some of the learning benefits associated with sustainability of water resources particularly in terms of: (a) information about how water resource management is traditionally held on

[6] So in sruktural position "Tuo Banda" higher than "Siak Banda". Thus Banda Siak more operational functions, while functioning in Banda Tuo took the policy and determine the direction

[7] See the explanation of the principles Hidronomika in the previous section.

[8] The nature of technology that divides water paraku automatically and proportionally not want the intensity of monitoring and high settings.

the hills (Upland area); (b) ideas about environmental conditions affecting the management mechanism and utilization of water resources by farmers, and (c) the ideas about the environmental conditions that can be adjusted *(adjustment)* to streamline the management of water resources by farmers.

Basically, these ideas can be incorporate into strategies used by the government so far in running the operation and maintenance of irrigation networks on a wider scale.

From these ideas, Study Center for Water Resources Irrigation Land and Development of Andalas University (PSI-SDALP Unand) has begun to design a study of the implementation of programs of agricultural systems in terms of local SRI that is known as "*Padi Sabatang*" at the level of tertiary network, in the case of the traditional irrigation system as "Paraku" .

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