HYSTORICAL PERSPECTIVE OF IRRIGATION MANAGEMENT IN INDONESIA[1] TOWARD A NEW WAVE OF DEVELOPMENT

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ABSTRACT

Irrigation management in Indonesia has been driven by two waves of hydraulic missions. The first was infrastructure driven type of development that happened during the colonial period from the mid of 19 century to the end of the first half of the 20th century. The purpose of this mission was to address the problem of poverty. The second hydraulic mission was carried out in response to the advent of green revolution and was used as one of the policy instruments to meet self-sufficiency in rice production. Closely related with these two missions were the stage of development of land and water use in river basins and the principles used in irrigation water management.

The policy reforms were used to address the problems of increasing investment cost and operation and maintenance expenditure of irrigation infrastructure whenever financial crisis hit Indonesian economy. As a result of the interplay of the interests of the stakeholders more complex water governance was then emerged as reflected in water law of 2004.Integrated Water Resource Management was considered solution to the conflict of interests between stakeholders. A broader concept of integration, however, is suggested to link land and water management particularly in response to possible impact of climate change. For this purpose a change in the way of thinking is necessary condition for the implementation of such a concept and for the emergence of new wave of development.

INTRODUCTION

Indonesia has a quite rich cultural and institutional endowment in irrigation water management in both public and communal irrigation systems. Most likely it has been related to the long experience in managing water following the invention of paddy cultivation around 16th century BC. The relatively simple and small scale irrigation systems, however, were found as early as the first century AD. These small systems have been developed over long period of time some with quite sophisticate principles and practices in water management. Many of them, however, are relatively simple in terms of capacity to deliver and distribute water. Despite they might be vulnerable to external shocks such as floods and droughts but because of the inherently strong social capital as a dominant feature, the local communities have been able to sustain their existence for centuries.

The history of public water governance in Indonesia is closely related to the development of public irrigation which began in the mid of 19th century in response to severe and long dry period that hit central Java. After about a half century try out irrigation was then used as one of the policy instruments along with education and people migration to cope with the problem of poverty and starvation. Large scale investment on irrigation was made and it was supported by the development of irrigation agency during the period of about a century (Vlughter, 1949). The irrigated

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area was increased significantly from about a million hectare at the beginning of the 20th century to 3.5 million ha at the end of the colonial period (Burger, 1975). This development as discussed in this paper is called the first wave of hydraulic mission.

The purpose of this paper is to highlight further changes in water governance as the government of Indonesia committed to carry out rice intensification program in response to the advent of green revolution technology and policy objective to achieve self-sufficiency in rice production. The changes that happened to characterize the second wave of hydraulic mission were not only in the scope of investment activities but also related to the stage of development of a river basin whereupon irrigation system situated.

Then, policy reforms to cope with the problems emerged during the second wave is discussed, they include the scope and the factors affecting the process of reform. Finally this paper discusses the emerging trend to implement integrated water resources management. The focus of discussion includes a broader framework to integrate land and water management and the change in the way of thinking as a necessary condition to implement such a concept.

IRRIGATION MANAGEMENT DURING THE ERA OF FIRST GENERATION HYDRAULIC MISSION (1849 -1949)

Infrastructure oriented bureaucracy

The famine that hit Central Java in 1848 following long period of drought was most likely the reason inspired the colonial government to initiate the development of durable and large scale irrigation systems as alternative to small scale community irrigation systems.

The first step taken was the development of hydraulic infrastructures namely head-works, canals, and control structures along the canals to divert water to the targeted area in the district of Demak, Central Java. The process of examination through trial and error approach was also triggered by the invention of technology to develop irrigation systems in relatively flat area of alluvial plain of Java. The next cycle of food crisis that happened in 1872 did not hinder further development of irrigation. Expansion of irrigation were further taken place in the nearby areas namely Gelapan and Tuntang, Central Java, and then proceeded to Sidoarjo at the delta of Brantas River Basin, East Java (Booth, 1974)

After about five decades examination, then irrigation was considered one of the important policy instruments to improve the welfare of the society. This period following Vlughter (1949) was called pioneering stage of development. Following pioneering was expansion stage that was the large scale investment that occurred during the first half of the 20th century.

In order to support the expansion stage, the second step was taken namely the development of irrigation bureaucracy. In response to increasing burden to handle operation and maintenance, irrigation agency was established in 1895 and gradually expanded in line with the expansion of irrigation infrastructures. Included in institutional building is rules and principles in water management.

Assessment of rules required to support management of irrigation system dated back to 1894 when irrigation bureaucracy examined two different rules in water allocation namely in two selected irrigation system namely *Pekalen* and *Pategoean* irrigation systems in East Java (Hasselmaan,1914). Pategoean represented localized irrigation system in a hilly area with a terraced rice fields most likely the system which was originally constructed by local communities and then its intake structure was

made permanent by irrigation agency. Water allocation and distribution within the system was autonomously undertaken by the local community.Pekalen represented the systems with relatively large in scale in alluvial plain of eastern part of East Java. The development of hydraulic infrastructures was made by irrigation agency to support sugarcane as export commodity in addition to rice and secondary crops.

Consequently the Pekalen regulation was based on the principle that water distribution should be controlled by the government. The establishment of a yearly "cultural plan" was the main feature of this regulation. A cultural plan used to have two major components namely the cropping system and the water distribution plan (Gruyter, 1933 and Graadt van Roggen, 1936). The cropping system plan referred to the arrangement of the crops within an irrigation system in a given time period while the water distribution plan referred to allocation and scheduling of water supply to meet crops demand for water of a given cropping system plan.

The water distribution plan aimed at fair water distribution among crops within an irrigation system, which during the colonial period implied fair water distribution between government promoted crops (sugarcane) and farmer's crops (paddy and secondary crops).

Pekalen regulation seemed the most likely fit to the ruler's interest in controlling water and in promoting sugarcane so that this regulation was definitely enforced since 1901. Even-though Pategoean regulation was not recommended by the colonial ruler, some reflections of its principle were practiced in various irrigation systems in Java (Witzenburg, 1936). Development of the *"Ulu-ulu Pembagian"*[3] institution sponsored by Humans in Pemali Comal systems, Central Java, referred to this principle (Graadt van Roggen, 1932 and Witzenburg, 1936). Irrigation water is proportionately distributed to all tertiary units within the irrigation system, and *Ulu-Ulu Pembagian* is responsible for water distribution within a tertiary unit.

As a further consequence of the enforcement of Pekalen regulation operation and maintenance of infrastructures required standard procedures for the whole irrigation systems. Development of yearly cultural plan implied a centralistic approach in water management. Therefore despite the recognition of the existence of community irrigation systems the general water law promulgated in 1936 adopted centralistic type of irrigation management.

The local farmer communities, however, have autonomy to manage irrigation at the tertiary level of the public irrigation system which has an average size of around 100 ha, more or less similar to the size of their traditional irrigation systems. This is the area where the interaction between individual farmers on water distribution takes place. Since individual farm water management practices to a certain extent depend on the process of interaction between individual farmers the water management at the farm level is essentially an integral part of water management at the tertiary level The challenge ahead is to develop low cost irrigation technology and to improve efficiency of water use.

[3] Ulu-ulu is a village official responsible for water management. In Pemali Comal systems, *Ulu-ulu pembagian* is responsible for water management at a tertiary unit. For further description of *Ulu-ulu* system in Java see for example Riss (1975) and Hutapea et al (1979).

Supporting studies on water management

Studies on irrigation water management during the colonial period, therefore, were generally undertaken within the context of Pekalen regulation, which was particularly related to development and improvement of cultural plan.

The earlier study was undertaken by Paerels and Eysvogel (1926), who measured the normal water supply in Pemali Comal irrigation systems, Central Java. They defined normal supply as that which causes no stress on crops during the crop growing season. In Pemali Comal irrigation systems it was about 0.25 liter/sec/ha to 0.35 liter/sec/ha assuming that all irrigated areas were planted with secondary crops.

Van Maanen (1931) studied the relationship between delivery requirement and size of irrigation unit (either tertiary or secondary unit). He stated that the greater the size of irrigation unit, the smaller the delivery requirement. This relationship was depicted in a well-known "Pemali curve" which has been used for a long time as the basic reference for designing canal capacity. (Figure 1). This difference in delivery requirement, however, was to a large extent caused by differences in water allocation. He found that rotation system was more easily implemented in larger irrigation units.

Study on irrigation water supply to secondary crops was done by Middleburg (1931) in Pemali Comal schemes. He defined "Pasten" [4] as a value to indicate supply to one *"bau"* [5] of crops measured at the tertiary turnout. If not specified, *Pasten* used to measured for 24 hour-supply per day. In Pemali Comal it ranged from 0.16 to 0.24 during the growing season for 14 hours daily supply.

Van der Giessen (1946) used normal supply and normal pasten interchangeably to indicate the amount of water supply required to meet agronomic optimal demand of the crops over time in responding to the changes in growth stages, rainfall, and moisture content of the soil. He suggested, for operational purposes, the normal Pasten should be predetermined in every two weeks period during the crop growing season.

As a further consequence of the cultural plan, in April 1928, the colonial ruler established a new institution, namely the "Golongan System" [6] (Gruyter, 1933). The two functions of the *Golongan* system were:

1. as a cropping system plan.
2. as a water distribution plan.

As a cropping system plan it aimed at continuous provision of land for sugarcane plantation, therefore continuously guarantying the level of sugarcane production. As a water distribution plan it aimed at efficient and fair distribution of water among the crops planted in an irrigation system

[4] *Pasten* in Javanese means fixed by God, so that no one is allowed to alter the amount of water allocated.

[5] One *Bau* is equal to 0.71 Ha.

[6] *Golongan* system refers to the staggering of planting dates successively among sections of irrigation systems, early in the planting season.

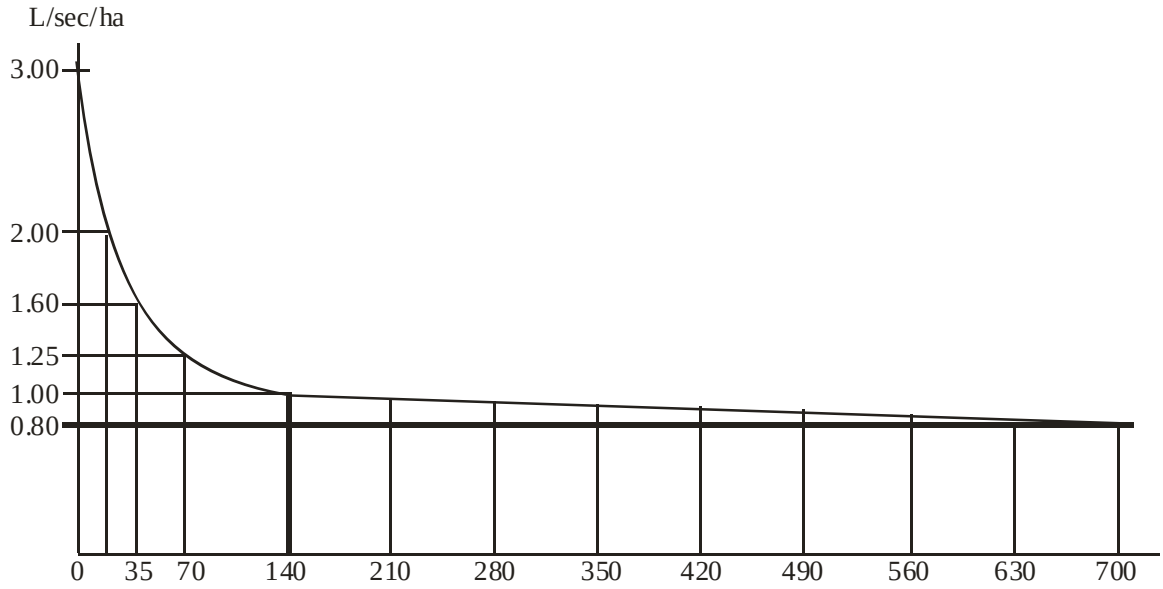

Figure 1 The Pemali Curve:
Relationship between area irrigated and water supply (from Van Mannen, 1931)

Van Maanen (1931) provided an illustration of how the *golongan* system was visualized as a water distribution plan. He described it as one of the forms of rotational system that occurred in the early period of the planting season. Water was allocated successively among sections of irrigation system based on relative demand of area irrigated of each section (Figure 2).

The number of sections required for the g*olongan* system depends on the status of flow into irrigation system and to some extent on the availability of labor for land-preparation. If for example five sections were planned for a certain system in a planting season but the available flow was sufficient for the last section to receive irrigation earlier, the land preparation for that section can be started earlier provided there were no constraints in labor availability. Consequently there were four sections realized of Golongan system for that particular season.

A tertiary unit with the-maximum size of 100 Ha was considered appropriate section for golongan system (Van der Giessen, 1946). By this arrangement it was possible to split the total area irrigated in a village into several sections of *Golongan* so that labor supply for land preparation could be appropriately scheduled.

Ideally, the *golongan* system should be rotated every year (the last section planted one year is the first to be planted the following year) to ensure equal benefits over time among farmers in different sections of *golongan*; some exception however might occur as noticed by Van der Giessen (1946) in Gung irrigation systems. The northern portion of this system closely located to the coast, had always been planted as a first section from year to year. This was necessary to avoid pest outbreak if the area was planted to paddy later in the season.

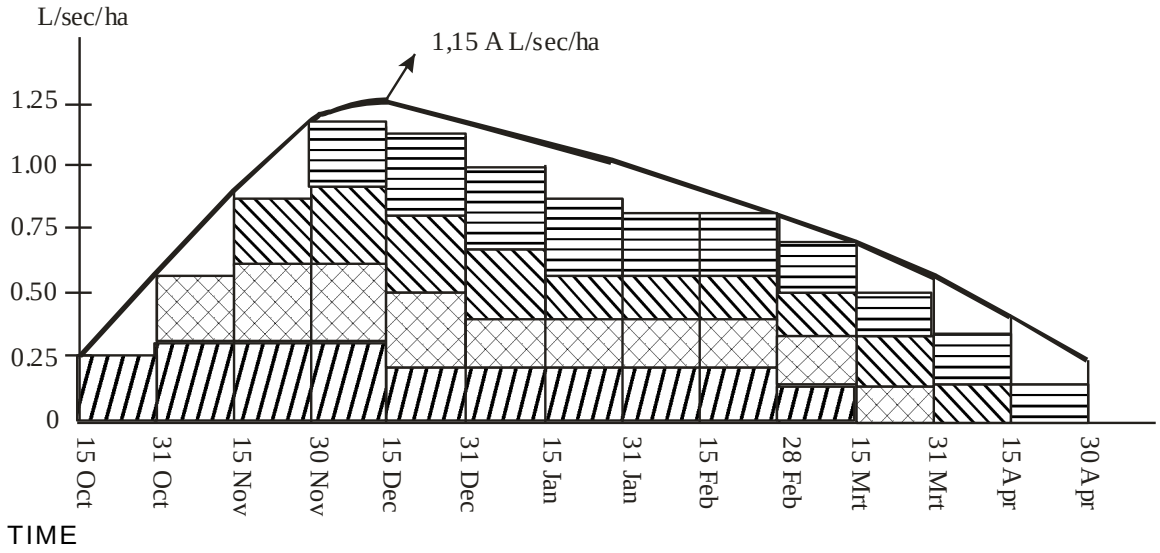

Figure 2. Water allocation over time in *golongan* system.

Notes - The shades in this figure indicates water allocation to the differential *golongan*. In the beginning of the season water is given only to the first *golongan*, than to the first and second *golongan* and later after the water is sufficient it is given to all four *golongans.*

One of the relevant issues related to the implementation of the *Golongan* system was allocation of water among the farmers' crops (paddy and secondary crops) and sugarcane. Fair water distribution during the colonial period was implemented in a form of "day and night rotation schedule" during critical water supply. The farmers' crops received water at night and sugarcane during the day. This regulation was considered unfair by the farmers, because sugarcane demanded less water than paddy and also because under "Glebagan regulation" [7] the sugarcane only occupied one third of the area irrigated in each village.

Construction of field reservoirs during 1918 to 1926 in the area planted to sugarcane was intended to overcome this water distribution problem. Swaan (1933) noted that in the tertiary supplemented by field reservoir *pasten* value can be maintained relatively high compared to the tertiary unit without field reservoir. He further stated that equal distribution of water can be undertaken since either surplus or deficit in available water can be shared equally between paddy and secondary crops on one side and sugarcane on another side. The change of *pasten* value before and after construction of field reservoirs, however, was not mentioned.

The development of field reservoirs was criticized by Metzelaar (1927) as not much affecting the cropping system particularly in the area planted to paddy. It was only useful to irrigate secondary crops and therefore their effectiveness to improve water distribution was yet uncertain. He noted further that better water distribution was not dependent on the availability of field reservoirs but on appropriate decisions and control of water allocation to the crops and paddy parcels within a tertiary unit.

A further effort to improve performance of water distribution in a tertiary unit was the introduction of "an hourly rotation schedule" in the period of critical supply, particularly in the area planted to paddy. However, the criteria required to undertake this rotation was not specified.

[7] Under Glebagan regulation, about one third of the area irrigated of the proposed village is always in cane and the farmers are forced to rent this land to the factory.

For the area planted to secondary crops, daily scheduling was recommended by Swaan (1933). He indicated that irrigation rotation for secondary crops can be scheduled in two-week intervals, and generally secondary crops only require four to six events of flooding during a planting season.

The criteria of water allocation among crops probably had been refined before 1936 when general water law was enforced (Van der Ploeg, 1937). It involved the relative irrigation requirement (RIR) for the farmers' crops and sugarcane and particularly for paddy, this requirement was further differentiated between the land preparation and growing periods.

The value of RIR varies from one irrigation system to another. In East Java, in eastern portion of Pekalen Sampean irrigation systems, the ratio of RIR was 3:1:1 for paddy, sugarcane and secondary crops respectively. In Madiun, the western part of East Java, the ratio of RIR was 3:1.5:1 for similar crops. Paerels and Eysvogel (1926) noticed that in the Gung irrigation system of Pemali Comal, the ratio of RIR was 5:3:2 for paddy, sugarcane and secondary crops respectively. Variation of this ratio was related to factors such as topography, ground water surface, rainfall and growing stages of crops. In the area where such RIR was not yet established, the normative RIR was recommended (Van der Ploeg, 1937). The ratio of normative RIR was 4:3:1.5:1 for paddy, fishponds, sugarcane and secondary crops respectively.

Another issue highlighted was appropriate unit of water distribution organization. Clason (1926) stated that Ulu-Ulu Pembagian (distributor ulu ulu) organized around the tertiary unit was more advantageous than village Ulu-Ulu system organized around the village territorial unit. One of the reasons was irrigation bureaucracy did not have to deal with more than one Ulu-Ulu to distribute water to each tertiary unit as in the case of the village Ulu-Ulu system. This U1u-Ulu Pembagian system however, only existed in some of the area of Pemali Comal irrigation systems and probably their expansion was constrained by the fact that the village Ulu-Ulu system had been established a long time before.

Institutional development of a water management system at the farm level in Java and Bali was reviewed by Happe (1935), Witzenburg (1936) and Polderman and Graadt van Roggen (1936). One of the controversial issues was centered around whether irrigation organization should be based on Balinese irrigation bounded system or Javanese village bounded system. This issue however, has never been resolved even during the postcolonial period.

Basic to the development of water management was the development of physical infrastructure or hard-ware component of irrigation system. Blommenstein (in Hendriks, 1979) based on the development of hydraulic engineering application in irrigation found that there are three stages of hard-ware technological development in Java. The following description is to fit the soft-ware component in each stage of Blommenstein classification.

The first stage was the development of irrigation system in the hilly area where the relatively simple hydraulic principle was used to deliver water into its service area. The communal systems and the early development of irrigation system by colonial ruler was included in this stage. The rule for water delivery was usually "continuous" supply and the need for water control was relatively minimum.

The second stage was the development of large-scale irrigation system in low land area, with the primary emphasize on the main delivery system. The problem of water allocation persisted during this stage, and the principle for water allocation were tested. The results from experiments were used as feed-back for design criteria of canal. (Pemali curve by Van Maanen, and Normal supply by Paerels and Eysvogel).

The third stage was indicated by further refinement of the water allocation system by further development of the physical infrastructures (field reservoirs, tertiary and quaternary distribution system). The concept of Pasten and *Golongan* system was developed during this stage where the information on crops planted and scheduling were taken into consideration.

At the end of the first generation in 1949 which last about a hundred years irrigation systems in Indonesia were dichotomized into public and community management. The community irrigation systems were considered small in size with low quality of infrastructure. However, the role of social capital in managing water was dominant so that the ability to repair the infrastructure and to sustain system management was high. As a consequence of self-governance cropping system was decided autonomously by local communities. On the other hand public irrigation systems were generally large in scale with high quality of infrastructure. Management of irrigation was centralistic with dominant role of irrigation agency. Cropping system was based on predetermined cultural plan to follow the supply driven type of irrigation management.

It is worth to note there were several important driving forces emerged such as food insufficiency and technology on hydraulic infrastructures that triggered the genesis of policy to expand large scale irrigation systems in Indonesia. Such a policy decision was made after a five decades period of tryout on infrastructural development and then followed by institutional development to support irrigation system management from the main system down to farm level. Furthermore, the need to support the sugarcane cultivation inspired the farmers to cultivate secondary crops in irrigated area and consequently to develop institutional requirement to manage irrigation for diversified crops both at the main system and farm level

IRRIGATION MANAGEMENT DURING THE ERA OF SECOND HIDRAULIC MISSION (1950 – 2004)

In order to address the problem of food insecurity and in responding to the advent of green revolution technology since late 1960s the second generation of water resource development was again emerged through a series of the five year development program. Quite similar with the first generation the driving forces were insufficiency of food and new technology; though in the case of the second generation it was the green revolution technology. Included in the second generation program was rehabilitation of the old systems from the first generation and expansion of irrigation systems to other islands.

Irrigation was considered one of the important policy instruments to achieve rice self-sufficiency. This second generation of hydraulic mission was generally supported by the assistance from the lending agencies such as the World Bank and the Asian Development Bank and also from bilateral funding sources. The scope of the second generation of hydraulic mission was larger than that of the first generation. During the first wave irrigation was the predominant feature of water resource development while during the second wave, in addition to irrigation, multi-purpose type of dams such as *Jatiluhur* in West Java and those in *Brantas* River Basin, East Java were also developed. During this period investment on flood protection was increasingly important through river management program and also reclamation of tidal swamp area to support national food production program. However, the investment cost of water resource development as indicated by the government expenditures per unit area was rapidly increased during this period (Pasandaran, 2002)

During this period despite high investment expenditure in water resource development, through centralistic and concerted approach on rice intensification in almost all of the irrigated land finally Indonesia achieved rice self–sufficiency in 1984. However, following the oil shock in 1986 public investment on water resource development had been steadily declined. This is possibly one of the reasons why in a later period Indonesia has some difficulties to sustain self-sufficiency in rice production.

Despite large irrigation investment, additional irrigated land during the second wave (from 1950 to 2004) was only about 50 percent of that achieved during the first wave. Expansion of irrigated land to other island was to certain extent offset by conversion of irrigated land to housing and industry in Java. Consequently the share of incremental irrigated land is relatively less as compared to that of the first wave.

However, productivity and harvested area of rice were increased significantly during the period between 1970 to 2002.(Pasandaran, et al, 2006) The share of Java in producing rice had been gradually declined and the share of Sumatra and other islands had been gradually increase.

Irrigated rice area was still the most important resource contributed to the total harvested area and production The share of the harvested area of irrigated rice was increased during the period between 1990 to 2000 from 66.8 percent to 73,9 percent but the share of production was only declined slightly from 85.4 percent to 84.5 percent. (Pasandaran et al, 2006)

The important lessons learned that can be drawn from about one and a half century of water resource management in Indonesia are as follows : (i) Both the first and the second wave of infrastructure development contributed significantly to the achievement of rice self-sufficiency.(ii) Infrastructure oriented public investment on water resource development particularly during the second wave tend to increase rapidly the government expenditure per unit area of investment program, and (iii) Introduction of green revolution technology accelerated the achievement of self-sufficiency in rice production.

The process of diversification in irrigated area, however, was not quite progressive during the second period of hydraulic mission. Production policy that only focused on rice self- sufficiency was most likely the reason for slow progress. As it was in the first generation period, diversification only happened in irrigated area used to be planted to sugarcane.

The rules to operate irrigation at the tertiary and farm level inherited from the first generation were still used with some modification because the rice varieties used were generally of high yielding varieties with shorter duration. Decision rules used include application of pasten and discharge curve, rotation at various level of system, and application of golongan at the beginning of planting season. In many systems, however, golongan systems has been practiced in larger scale with the consequence of relatively long period of staggering in planting dates.

Because of the increasing pressure to exercise higher cropping intensity conjunctive use of water between groundwater and water from tertiary units were increasingly practiced in the area of highly diversified cropping system such as that in the Brantas River Basin, East Java.

Water users associations were generally introduced and expanded during the second period along with the implementation of government project to rehabilitate the old irrigation systems or to develop new project. At the beginning of the implementation period the effectiveness of such an approach, however, was questionable as it was considered conflicting with the traditional farmer water management institutions.

Table 1 shows the comparison of achievement of the first and second generation of hydraulic mission.

Table 1 Achievement of the first and the second generation of hydraulic mission

	First Generation	Second Generation
Period	1848 – 1949	1950 -2004
Area expansion	2.5 million ha	1.5 million ha
Investment cost	Low	High
Infrastructure	High quality	Low quality
Rehabilitation Cycle	Around 50 years Low	Around 20 years
Rice Productivity	Low	High
Rice Cropping Intensity	Limited to a certain irrigated area	High
Diversification	Food insufficiency and technology on infrastructure	Limited to a certain irrigated area
Driving Forces	Traditional local systems	Food insufficiency and green revolution technology
Farmer institution		Water users associations

Although expansion of irrigated area during the second period was less than that of the first period but productivity and rice cropping intensity during the second period was high. However, investment cost per unit area during the second period was high. This is to indicate that despite technology on infrastructure is necessary but it is not sufficient to improve productivity. The challenge ahead is to develop low cost irrigation technology and to improve efficiency of water use.

STAGE OF DEVELOPMENT

Another lesson learnt from the two hydraulic missions in Indonesia is that the first hydraulic mission was undertaken during the period when land and water were relatively easy to access as it is compared to the second mission. Although irrigation development in the mid of 19 century was also triggered by long and severe dry period that was occurred in Central Java but this was an extreme climate variability that can hit any locality in Indonesia. Population of Java in the mid of 19 century was less than 10 percent of the present population and the natural resources such as forest was still well maintained. This is considered the first stage of development of land and water characterized by rapid development of irrigated and rainfed area, with rice as a dominant crop, abundant availability of water with relatively low economic value (Table 2).

Table 2. Stage of Development of land and water use in River Basin

No.	Stage 1	Stage 2	Stage 3
1.	Expansion of Rainfed and irrigated area	Declining rate of growth of irrigated area and rainfed	Rapid decline of irrigated area and rainfed
2.	Single crop dominantly planted to rice	Increasing diversified crops	Highly diversified farming system
3.	Excess supply of land and water	Improving water use and efficiency	Transfer of irrigation to other high value crops and to other sector
4.	Low value of land and water	Increasing value of land and water	High value of land and water
5.	Insignificant conflict of land and water	Local conflicts of land and water	Conflicts of land and water between sectors

Source: Pasandaran, et al, (2006)

In the second stage of development the land available for irrigated area began to decline, demand for water from non agricultural sectors began to increase and scarcity of water began to appear locally. Depending on the degree of scarcity some conflicts among water users may have occurred within a block of irrigated lands or between blocks. Irrigated land adjacent to urban began to be converted for housings and industry. At this stage there was no further expansion of irrigated land in a river basin but an internal shift may be occurred, for example, from the one with low cropping intensity to the one with more diversified farming system. The process of transformation was taken place to improve efficiency of land and water resources for production.

During the third stage of development further declining of rice field occurred significantly as a consequence of rapid increase in demand for land and water from non agricultural sectors such as industry and housing. As water scarcity expanded the conflicts in water use not only happened between water users in irrigated land but also between the users of different sectors. The inter basin transfer of water used to happen to meet the growing demand for water from urban population.

The stage of development of land and water management in Indonesia can be also considered as the context for the hydraulic missions. The first hydraulic mission was generally carried out in the first stage of development where accessibility to land and water was relatively easy. Consequently irrigated area was rapidly increased. During the period of the second hydraulic mission, however, access to land and water particularly in Java began to decline since many of the rivers basins in this island were already in stage two, and some others were in stage three. The room for expansion of irrigated area then was only available to other islands where many of the river basins were still in stage one. But the problem with the stage one irrigation expansion is it used to take long time, in some cases may be around 10 years, from the onset of irrigation construction to the achievement of full production potential of new irrigated land.

On the contrary irrigated land in the stage two and three as in the case of Java used to have high productivity and also high cropping intensity. Therefore conversion of some parts of irrigated land in this stage can not be compensated by those of the same size of irrigated land in stage one. It requires much larger size of irrigated land

to compensate the loss of irrigated area in stage three. Further more as conversion of irrigated land continue to take place as in the case of rapid process of urbanization in some of the river basins in Java not only food production will decline but also environmental services will be disturbed.

The effect on environmental service will be more severe as the forested area continues to decline. The cultural heritage in managing natural resources such as land and water may be gradually disappeared. The effect of the continuing trend of land and water uses in stage three may cause not only food security disaster but also ecological disaster. This continuing trend in a river basin of the stage three as depicted in figure 3 can be labeled *Java Syndrome* to represent river basin with a declining food production capacity and environmental degradation.

POLICY REFORMS: CHALLENGES AND OPPORTUNITIES TOWARD A NEW WAVE OF DEVELOPMENT

General Water law promulgated in 1936 provided legal basis for the first hydraulic mission to operate. The period of about a half century was needed to examine investment approach in irrigation development before it was finally declared in 1901 as one of the policy instruments to improve the welfare of the natives. Further it took about three decades to assess the appropriate institution to support operation and maintenance of irrigation infrastructure. Irrigation bureaucracies emerged in regions where public irrigation infrastructures were developed. The government institutionalized irrigation committee to determine cultural plan for irrigation systems in the district. Essentially Irrigation management during this period was centralistic with the provincial government in charge of operation and maintenance of irrigation infrastructure.

One of the dominant features of centralized approach is *supply driven* where water used to be delivered to the tertiary turnouts and then distributed by the local farmer communities to the authorized rice fields based on the pre-determined cultural plan.

This management approach was continually exercised during the second wave of hydraulic mission in spite of the change in the stage of development. The law on water resources promulgated in 1974 to replace the one of 1936 only slightly expanded the coverage of water resource management to include emerging issues such as river management and flood control. The project oriented approach was used to implement the investment program with emphasize on structural development but relatively less attention was paid to operation and maintenance of irrigation systems. As consequence the vicious cycle of deferred maintenance and rehabilitation used to occur frequently (Suhardiman, 2008).

Another trend happened during this period was the cooptation of the irrigation system developed by the local communities into the domain of public irrigation. This trend used to occur when the irrigation agency assisted the local communities in improving their irrigation infrastructures. However, the aftermath of the oil shock that hit Indonesian economy in 1986 the government expenditure on irrigation both from external and as well as from internal funding sources (national development budget) tend to decline while the burden on operation and maintenance tend to continually increase.

To cope with this problem *irrigation operation and maintenance project* (IOMP) was created under the funding support of the World Bank *irrigation sector adjustment loan*. The main objective of the project was to cut off the vicious cycle by introducing special maintenance on the irrigation systems that required improvement prior the introduction of efficient operation and maintenance practices. The scope of activities

included in the program of the sector loan was the introduction of irrigation service fee to the water users association and also the transfer of management of the small scale irrigation system of less than 500 ha to the water users association.

However, since the transfer of irrigation management was not essentially belong to the interest of irrigation bureaucracy the impact of this policy reform was not as intended. The vicious cycle again emerged and the tendency to take over the management of irrigation system managed by local communities to the domain of public irrigation reappeared.

A much severe financial crisis again hit Indonesian economy for several years since 1997. As usual during such a period the pressure to reform irrigation policies again reappeared since the capacity not only to continue public investment but also to operate and maintain the existing irrigation system was weakened. A broader concept of the transfer of management was introduced through *presidential decree* of 1999 and latter followed by the *government regulation* of the year 2001. Quite different with the one in 1987, it involved the transfer of irrigation system as a whole to the water users associations. As the water users may not be well prepared to undertake such a responsibility the institutional capacity building was included in the program of the policy reforms in addition to the program to redefine the role of irrigation agency at the various level of administration. At about the same time the government administration began to be decentralized to the district government, and consequently such a district government was supposed to have a jurisdiction in supervising the management of the irrigation in their jurisdictional area. All these developmental changes complicated the governance of irrigation systems in Indonesia and consequently the need for a new water law was badly needed to resolve the conflicting issues and interests.

However, as the economy tend to recover after several years of crisis and the government capacity to finance the public investment began to improve, bureaucratic interest again dominantly reappeared in the process of formulation of the law. The regulation to decentralize functionally the management of irrigation system to the water users association was cancelled by the new water law of 2004. As a consequence, irrigation agency again dominated the management of irrigation systems although the jurisdiction to manage the systems was shared to the hierarchical administration from the central down to the district administration.

Despite the complexity of irrigation management the new water law has provided the legal basis for the concept of the *integrated water resource management* (IWRM) to be exercised in a *River Regime Unit* (RRU) which consists of either a single river basin or several interrelated river basins. The new law also recognized the role of multi-stake holders in the process of decision making in water governance.

The IWRM though it has been recognized globally and it has been recommended by various international forum such as International Water Forum in Hague, Netherland, in the year 2000 and the World Summit on Sustainable Development(WSSD) in Johannesburg in 2002, in particularly it is continually being promoted by the Global Water Partnership (GWP, 2003) but it is considered an ideal and a challenging concept; there has been no case so far that can be used as a reference in implementing such a concept.

As the role of the government bureaucracy in shaping water governance is so dominant, integrated approach can be only successfully implemented if there was a serious political commitment to involve all the stake holders in the process of decision making.

One of the challenges is to develop broader framework of governance namely the need to link land and water management in each stage of development of a river basin. The experience so far indicated that the decision on land use has influenced the characteristics of water flow and water quality in a river basin; on the other hand the decision on water management has been also affecting the productivity of land. The concept of the stage of development, so far, has been used to emphasize the importance of economic efficiency as the main criteria in resource allocation. Such a tendency, for example, had been reflected in the declaration of *Dublin conference* in 1992 where water was considered as economic commodity. Later it was recognized that water has a social function too as it was reflected in the World Summit in Rio de Janeiro in 1996.In the WSSD in the year 2002 environmental sustainability was emphasized as an integral part of the IWRM. Essentially integrated approach involves *efficiency, equity, and environmental sustainability* (Molle, 2008).

However, the abovementioned concept applies as well to land resource management. The problem of efficiency emerged as the land scarcity occurred in response to rapid population growth and increasingly intense economic activities that require lands. On the other hand the land available per capita has been declining over time (Smill, 2000) and it has also not been equally distributed. A continuing trend on the change of land use as in the case of the stage three river basins may further disturb ecosystem services.

Therefore the concept of *integrated land and water resource management* that provides the framework for the balanced and harmonious relationship between the three pillars i.e. efficiency, equity, and environmental sustainability has to be introduced.. For example the private sector might be interested in the privatization of resource allocation for the sake of economic efficiency while those who struggle for equity consideration may raise the issues such as agrarian reforms, gender, and improvement in accessibility to land and water. The stakeholders who struggle for environmental and cultural sustainability may be interested in the issues such as adaptive management of natural resources, integration of social capital in the management of river basin and conservation of cultural heritages.

Consequently, another challenge is a need to create a platform to harmoniously facilitate the process of integration between the interested stakeholders. The process of facilitation includes capacity building to comprehend the nature and the concern of integration at national down to the district level administration and whenever necessary at the level of river basin. The capacity to exercise the right partnership has also to be included in the capacity building process. To support the facilitation process, investments are also required to build knowledge, and to reform and develop institutions. Research and advocacy are stepping stones toward better management. Investment itself is not enough; it needs to be accompanied by political commitment to implement this conceptual framework of land and water governance.

As a further consequence the changes in the way of thinking are needed to implement the overall framework of land and water management. The principle that dictates the change in the way of thinking is the need to change from the narrowly focused management to a broader concept of land and water management approach by taking into account the balanced and harmonious relationship between economic efficiency, equity, and environmental sustainability. There are at least three changes in the way of thinking has to be considered as shown in Table 3.

Table 3 Changes in the way of thinking

Past way of thinking	Future way of thinking
Water management is focused in irrigated area only.	Broad water management spectrum; it utilize blue and green water; it includes broad spectrum of land i,e, rainfed, swamp, land for aquaculture and livestock.
Comodity based land management	An integral part of ecosystem services; Flexible and adaptive to the process of diversification in response to the scarcity of resources
Dominant interest of government sectors in land and water management	Involvement of multi –stakeholders in decision making process with a broad spectrum agenda

First, water management should not only focused on irrigated area but its scope should include a broad spectrum of land use such as rainfed, swampy area, pastoral and livestock based area, aquaculture, and it should also strengthen the interlink between agriculture and non agriculture uses. All possible sources of water, both blue and green water, have to be taken into account, in serving a broad spectrum land uses.

Second, the management of land use should not only commodity based but it should be considered as an integral part of ecosystem services. The management should be flexible enough to facilitate the process of diversification and adaptation in response to external shocks resulting from climate variability..

Third, the management of land and water should not be driven by the interest of sector but it should be based on integrated process to facilitate the multi-stakeholders decision making.

The policy reform through new water law is necessary but not sufficient condition for the emergence of new wave of development. However, the opportunities are open only if the way of thinking as mentioned above is changed and constraints such as rent seeking behavior and the struggle to sustain the interest of bureaucracy could be gradually eliminated.

CONCLUSIONS

The current irrigation management in Indonesia has been basically driven by two waves of hydraulic missions. The purpose of the first wave was to address poverty. In addition to development of infrastructure public irrigation bureaucracy in charge of investment on irrigation infrastructure and operation and maintenance of irrigation systems were established. Water management institutes to support the pre-determined cultural plan were also established.

The second wave was driven by the need to meet the self-sufficiency in rice production in response to green revolution technology. The scope of the second wave was broader than that of the first but the government expenditure for investment per unit area was growing rapidly.

The water governance during the second wave was also characterized by the change in the stage of development of a river basin. As further consequences were the conversion of irrigated land and the transfer of water to meet the growing demand for land and water from urban and industry. The continuing trend on conversion of

land uses as in the case of the river basin of the stage three may cause not only declining of food production capacity but also degradation of environmental services.

The severe economic and financial crisis which hit the country for several years since 1997 reduced the government capacity in public investment and in operation and maintenance of infrastructure. This crisis was used to trigger policy reform to transfer the management of irrigation to the water users. However, once the economy was recovered the interest of bureaucracy to recentralize the management of water resources reappeared as it was reflected in the implementation of water law of 2004. As a result water resource management in general and irrigation management in particular becomes more complicated

The emerging trend as required by the new law is the implementation of integrated approach in water resource management. As water resource management is also closely related to land management in each stage of development of a river basin, a broader concept of integration is needed. Although the new law is necessary condition to develop a framework of integration but the change in the way of thinking is needed prior to the emergence of the new wave of development.

References

AES,1975. Benefit Monitoring Study of Rentang Irrigation Project West Java (Second Study, sample survey I, 1977/78) Agro Economic survey report No. 4/80/2.

Bappenas,2003; Kajian Kerangka Kerja Model Pengelolaan Daerah Aliran Sungai (DAS) Terpadu. Bappenas, Jakarta

Booth, Anne. 1974. “irrigation in Indonesia, Part II.” Bulletin of Indonesian Economic Studies.

Burger, D.H.1975; Sosiologisch-Economische Geschiedenis Van Indonesian, deel ii, Indonesia in de 20e eew,KIT; Amsterdam, 1975

Clason, E.W.H., 1936. Economische beschouwingen over de izrigative op Java on Madoera, (Eeconomic evaluation for irrigation in Java and Madura) De inginieur Netherlandsch, lndie.

Global Water Partnership (GWP), 2003; Unlocking the Door to Social Development and Economic Growth: How a More Integrated Approach to Water Can Help, Policy Brief,GWP, 2004.

Graadt van Roggen, J.F. 1935. Plant en water regelingen in de Provinciale waterstaats afdeling "Pemali Comal" (Plant and water control in Pemali Comal irrigation scheme). De ingenieur in Ncdcrlandsh-Indie 1935.

Gruyter, De P., 1933. Plant en water regelingen (plant and water control) De waterstaats. Ingenieur No. 1. 1933.

Happe, P.L.E.,1936; Water beheer and water schappen: De Ingenieur in Nederlandsh Indie, No. 8-1936.

Hasselman, C, J. 1914. Algemeen overzcht van de uitkomsten van het welvaart onderzoek, gehoudcn op Java en Madoera in 1904-1905. S'gravenhage:Martinus Nijhoff, 1944.

Hendriks, Willem J., 1979. Daerah aliran sungai Cimanuk sebagai suatu ekosistem. Pengendalian dan penguasaan air dan tanah. (Cimanuk river basin as an ecosystem. Control on water Land). Lokakarya sejarah sosial ekonomi

pedesaan, Cipayung 22-24 Januari 1979. Survai Agro ekonomi, Erasmus Universiteit Rottcrdam, Institut Pertanian Bogor.

Maanen, Th. D. Van, 1931. Irrigatie in Nederlandsch indie. (Irrigation in Indonesia), Uitgave, Visser and co., Batavia.

Metzelaar, J.Th., 1932: Het wadoekstelsel en zijn waarde voor den Landbouw (Buiteuzorg, Java) V II, 1931/32.

Middleburg, D.J.A.,1937. Waarnemingen Betreffende water verbruik op Mais, Aardnoten en Uien in de Rcsidentie Pekalongan in 1930, 1931, en 1932. (Observation on water requirement of corn, peanuts, and onion in Pelcalongan in 1930, 1931 and 1931). Landbouw, Buitzenzorg, Java, XII, No. 9, 1937.

Molle, F,2008; Nirvana Concepts, Narratives and Policy Models: Insights from the Water Sector. Water Alternatives 1(1): 131-156. www.wateralternatives.org

Pasandaran, E, 2008; Irigasi Masa Depan Memperjuangkan Kesejahteraan Petani dan Ketahanan Pangan , JKI- Indonesia.

Pasandaran, E, P. Simatupang, dan A.M. Fagi, 2006; Perspective of Rice Production in Indonesia, Sumarno, Suparyono, A.M. Fagi, Made Oka Adnyana (eds), Rice Industry, Culture, and Environment, Book one, Indonesian Centre for Rice Research, IARRD; Jakarta,

Pasandaran, E, 2002; Pokok- Pokok Pemikiran tentang Kebijakan Investasi di Bidang Pengairan, dalam Sutopo Purwo Nugroho, Seno Adi, Bambang Setiadi (eds.), Peluang dan Tantangan Pengelolaan Sumber Daya Air di Indonesia, P3-TPSLK BPPT dan HSF: Jakarta

Paerels, B.H. en Eysvogel, W.F.,1926. Eenige opmerkingen omtrent waterverdeeling. De waterstaats ingenieur 14 (1926): 338-378.

RISS, 1975. A Research on Water management at the Farm Level. An Indonesia case study. Research institute in social Sciences. Satyawacana-University Salatiga-Indonesia, 1975.

Suhardiman, D, 2008; Bureaucratic Designs The Paradox of Irrigation Management Transfer in Indonesia, Doctoral Disertation, Wageningen University.

Swaan, W., 1933. water verdccling in Het tertiare vak. (water distribution in Tertiary Unit), de waterstaat ingenieur, No 7, 1931.

Van der Giessen, C., 1946. Bevloeing van Rijst op Java en Madoera, (irrigation of rice in Java and madura) Landbouw, Batavia, Java, XIX, P 99-121.

Van der Ploeg,J.1937. Eenige Landbouwkundige aanteekeningen bij het algemeen waterreglement 1936. (Some agricultural notes regarding general water law), Landbouw (Buitenzprg, Java) XIII No. 7/8 P 1-24.

Vlughter, H., 1949; Honderd Jaar irrigatie, Voordracht Gehouden op 18 October 1949 ter Gelegenheid van de Herdenking van de Overdracht van de Technische Hoge School aan den Lande in 1942, Druk Voorkink: Bandung.

Witzenburg, J. H. van, 1936, Waterrbeheer en waterschappen (irrigation management and irrigation scheme), de ingenieur in Nederlansch indie, vo16.