PROGRAM STUDI MAGISTER TEKNIK SIPIL
FAKULTAS TEKNIK
UNIVERSITAS UDAYANA
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SeNaTS 2

SEMINAR NASIONAL TEKNIK SIPIL

MENUJU PEMBANGUNAN INFRASTRUKTUR YANG BERKELANJUTAN

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Sanur-Bali, 8 Juli 2017

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KATA PENGANTAR

Kemajuan ilmu pengetahuan dan teknologi diharapkan dapat meningkatkan kesejahteraan manusia. Namun dalam pengembangan dan aplikasinya, disamping memberi dampak positip juga berdampak negatip. Dampak negatip ini sering tidak mendapatkan perhatian dan pengembangan selanjutnya mempengaruhi ketersediaan sumber daya alam dan kondisi lingkungan. Kondisi ini, sampai tingkat tertentu, dapat mengurangi manfaat yang dituju atau bahkan membahayakan keberlanjutan eksistensi bumi dan kehidupannya. Kesadaran akan hal ini mendorong ilmuwan, rekayasawan maupun praktisi dalam berbagai bidang mengembangkan teknologi ramah lingkungan yang menjamin keberlanjutan bumi dan isinya.

Bidang Teknik Sipil merupakan salah satu pelaku utama dalam pembangunan infrastruktur yang berperan penting dalam mewujudkan pembangunan berkelanjutan. Adanya dampak kemajuan teknologi di bidang konstruksi mengharuskan pengguna maupun pelaku industri konstruksi agar tetap menjaga keseimbangan lingkungan. Tak dapat dipungkiri, faktor pelestarian lingkungan memegang peranan penting untuk mewujudkan pembangunan berkelanjutan.

Untuk mendukung perspektif tersebut, maka Program Studi Magister Teknik Sipil, Fakultas Teknik, Universitas Udayana pada hari Sabtu tanggal 8 Juli 2017 menyelenggarakan Seminar Nasional Teknik Sipil (SeNaTS) 2 dengan tema “Menuju Pembangunan Infrastruktur Yang Berkelanjutan” di Inna Grand Bali Beach, Sanur, Bali.

Kegiatan ilmiah sehari ini diharapkan dapat menjadi salah satu sarana komunikasi dan wadah tukar informasi bagi pendidik, peneliti dan praktisi di bidang Teknik Sipil maupun mahasiswa untuk mendukung upaya terlaksananya pembangunan infrastruktur berkelanjutan. Sejumlah tujuh puluhan makalah dipresentasikan dalam kegiatan SeNaTS 2 ini dari beberapa bidang keahlian meliputi bidang keahlian: Struktur dan Material, Geoteknik, Transportasi, Manajemen Proyek dan Rekayasa Konstruksi, Sumber Daya Air dan Lingkungan. Penulis makalah berasal dari berbagai institusi di seluruh Indonesia.

Terselenggaranya kegiatan seminar ini berkat peran serta dan bantuan berbagai pihak, dari tahap persiapan sampai pelaksanaannya. Untuk itu kami mengucapkan terima kasih yang sebesar-besarnya. Semoga komunikasi dan kerjasama yang telah terjalin dapat berlanjut di kemudian hari.

DAFTAR ISI

BIDANG GEOTEKNIK

BIDANG MANAJEMEN PROYEK DAN REKAYASA KONSTRUKSI

BIDANG TRANSPORTASI

BIDANG SUMBER DAYA AIR

BIDANG LINGKUNGAN

WATER ALLOCATION AND DISTRIBUTION IN JATILUHUR IRRIGATION AREA INDONESIA: EVALUATION AND CHALLENGES

Rahmat Sudiana[1], Doddi Yudianto[2], Zhang Xiuju[3]

[1]*Student of Joint Master Double Degree Program Parahyangan Catholic University Indonesia and Hohai University China in Water Resources Engineering*
Email: ma2t007@yahoo.com
[2]*Civil Engineering Department, Parahyangan Catholic University Indonesia*
[3]*College of Hydrology and Water Resources, Hohai University China*

ABSTRAK

Indonesia memiliki sumber daya alam yang kaya termasuk sumber daya air. Melimpahnnya sumber daya air ditandai dengan rata-rata curah hujan tahunan sekitar 2790 mm. Daerah irigasi jatiluhur merupakan salah satu sistem irigasi besar di Indonesia yanng mana memainkan peran utama dalam ketahanan pangan dan pertanian nasional. Daerah irigasi Jatiluhur menerima air dari Waduk Serbaguna Jatiluhur yang terletak di Sungai Citarum Jawa Barat. Waduk ini bertanggung jawab mengairi 240.000 ha sawah, air baku untuk domestik, perkotaan dan industri (DMI) dan pembangkitan listrik. Air dialirkan dari waduk menuju Bendung Curug dimana air dibagi menuju Saluran Tarum Barat (STB), Saluran Tarum Timur (STT) dan Saluran Tarum Utara (STU). Mekanisme alokasi dan distribusi air secara profesional dikelola oleh Perum Jasa Tirta II (PJT II). Meskipun peberian sistem irigasi tampak berjalan baik, beberapa aspek masih perlu peningkatan dan pengembangan. Hal penting untuk peningkatan adalah kualitas dan keandalan basis data yang diperlukan untuk menyiapkan rencana alokasi dan jadwal pemberiann air. Pengembangan masa depan yang mana akan meningkatkan total permintaan air juga diperhitungkan. Oleh sebab itu, perlu dilakukan investigasi seberapa efisien sistem yang berjalan saat ini dan peningkatan apa yang bisa diajukan untuk meningkatkan efisiensi penggunaan air menyeluruh. Neraca air pada sistem irigasi Jatiluhur secara teori mampu memenuhi permintaan air sampai dengan Tahun 2025 tetapi isu perubahan iklim harus dipertimbangkan dimana periode musim kering dan musim basah akan berganti. Berdasarkan skenario riset yang ada musim kering akan lebih panjang dan musim basah akan lebih pendek dengan curah hujan lebih tinggi.

Kata kunci: *Daerah irigasi Jatiluhur, Waduk serbaguna Djuanda (Jatiluhur), alokasi dan distribusi air, efisiensi air, neraca air*

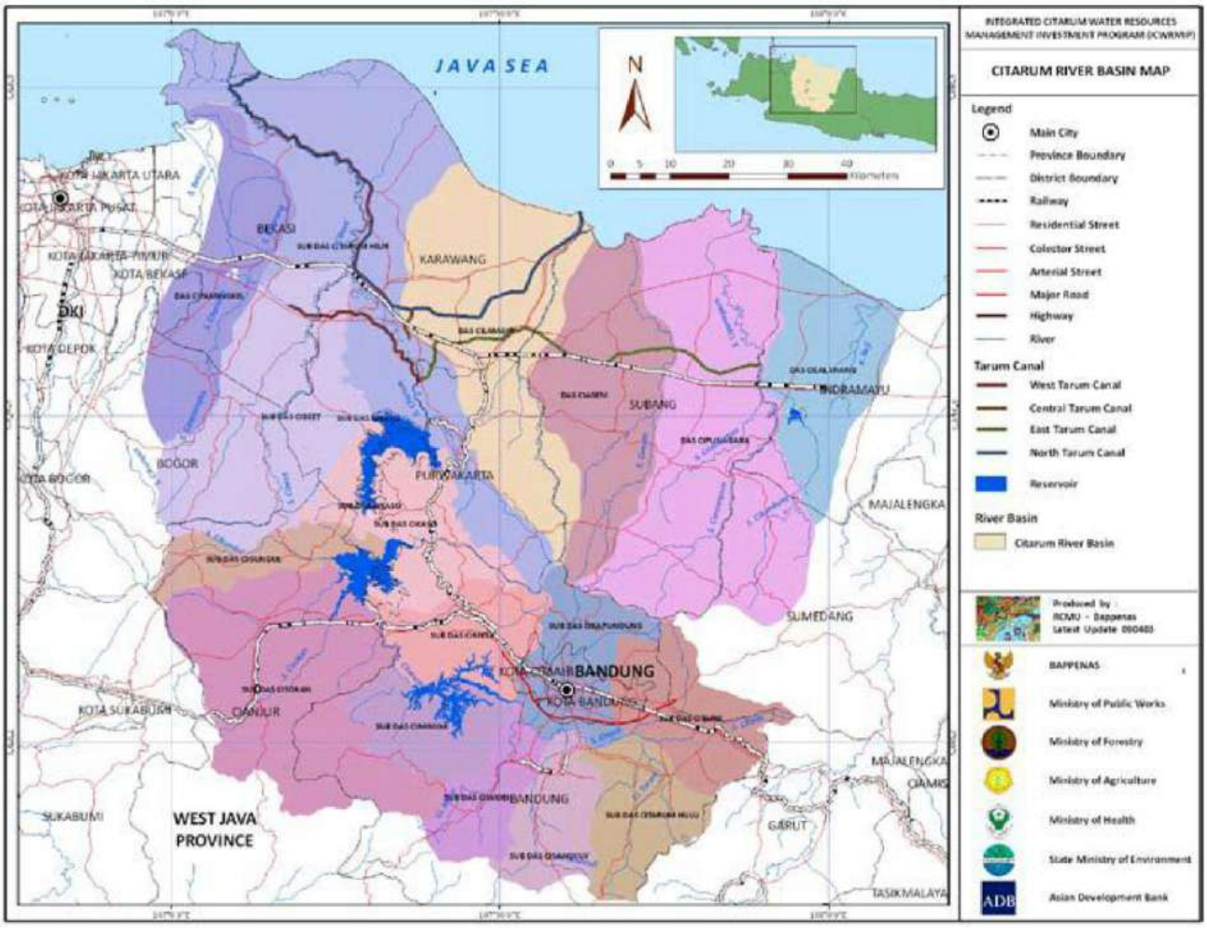
ABSTRACT

Indonesia has rich natural resources including water resources. The abundance of water resources is characterized by an annual rainfall averaging about 2790 mm. Jatiluhur irrigation area is one of large irrigation system in Indonesia which plays main role for national food and agriculture defense. It receives water from Djuanda Multipurpose Reservoir located in Citarum River West Java Indonesia. This reservoir is responsible to irrigate 240,000 ha paddy field, raw water for domestic municipal industrial (DMI) and hydropower generation. The water is released from the reservoir to Curug Diversion Weir where the water is diverted to West Tarum Canal (WTC), East Tarum Canal (ETC) and North Tarum Canal (NTC). Mechanisms for water allocation and distribution are professionally managed by Jasa Tirta II Public Corporation (PJT II). Although provision of irrigation system seems performing well, some aspects still need improvement and development. The important issue for improvement is quality and reliability of basic data required to prepare the water allocation plan and distribution schedule. Taking into account future developments which will increase combined water demand. Consequently, there is a need to investigate how efficient the system is working currently and which improvements can be proposed to increase overall water use efficiency. Water balance in the Jatiluhur irrigation system theoretically capable to fulfill water demand until 2025 but climate change issue should be considered as period of dry season and wet season will be shifted. Based on the research scenario, dry season will be longer and wet season will be shorter with more intense rainfall.

Keywords: *Jatiluhur irrigation area, Djuanda multipurpose reservoir, water allocation & distribution, water efficiency, water balance*

1. INTRODUCTION

The Citarum River is located in West Java and is about 350 km long originated from Mount Wayang of Garut Regency then flows away heading to Java Sea. This situation can be illustrated in Figure 1. Water is stored in three connected reservoirs Saguling, Cirata and Djuanda. The Djuanda reservoir was build in 1957 -1967, with the purposes to irrigate about 240,000 ha, generate electricity with installed capacity 187.5 MW and supply bulk water with a discharge of about 16 m3/s. The Jatiluhur irrigation area receives water from The Djuanda Multipurpose Reservoir. The Water is released from The Djuanda reservoir to The Curug Diversion Weir where it is diverted to The West Tarum Canal (WTC) and The East Tarum Canal (ETC). Part of the flow is passing The Curug Weir to the north direction and diverted at The Walahar Weir to The North Tarum Canal (NTC). The irrigation system is designed to provide two times paddy and occasionally "palawija" (fruits and vegetables). The West Tarum Canal is about 69 km long and has a command area of about 56,977 ha. The East Tarum Canal is about 67 km long and has an irrigated area of about 92,613 ha. The North Tarum Canal is about 77 km long and has a command area of about 87,396 ha.



Source: *Integrated Citarum Water Resources Management Investment Program (2009)*

Figure 1. Map of Citarum River Basin

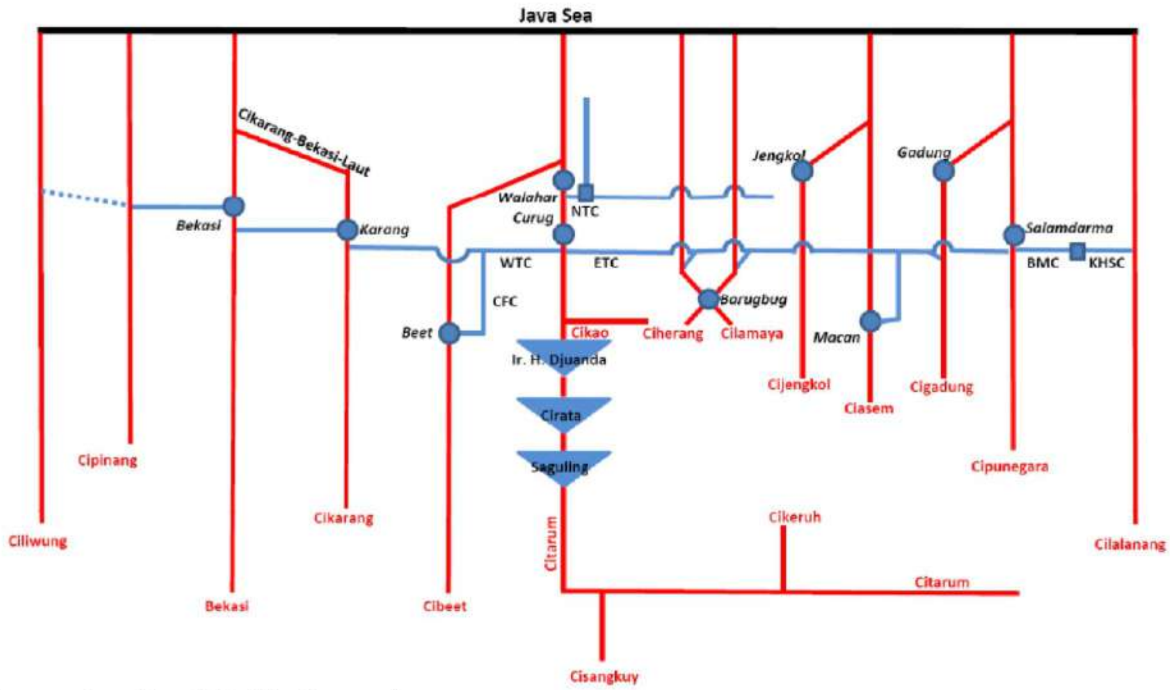
It is important to realize that the system is interconnected with four rivers at The West Tarum Canal and four rivers at The East Tarum Canal. Discharges from these rivers are captured and diverted to the irrigation system. The average annual flow of water in the basin is 12.95 billion m^3 and by exploiting the existing water resources infrastructures (the reservoir and the interconnected rivers) the water that could be regulated is about 7.65 billion m^3 annually. Schema of the Jatiluhur Irrigation System is presented in Figure 2.

The system was originally equipped with cross-regulators, romijn weirs and tertiary sliding gates with measurement devices behind it like *cipoletti* weirs. In fact in its original state, water discharges could be monitored and controlled throughout the system. However in the last decades the system has degraded due to lack of maintenance.

2. ORGANIZATION

Management organization of the Jatiluhur Irrigation System is under responsibility of Jasa Tirta II Public Corporation (PJT II). Figure 3 describes simplified management organization of the Jatiluhur Irrigation System. The State Owned Enterprise Jasa Tirta II Public Corporation is divided over 5 divisions as follows:

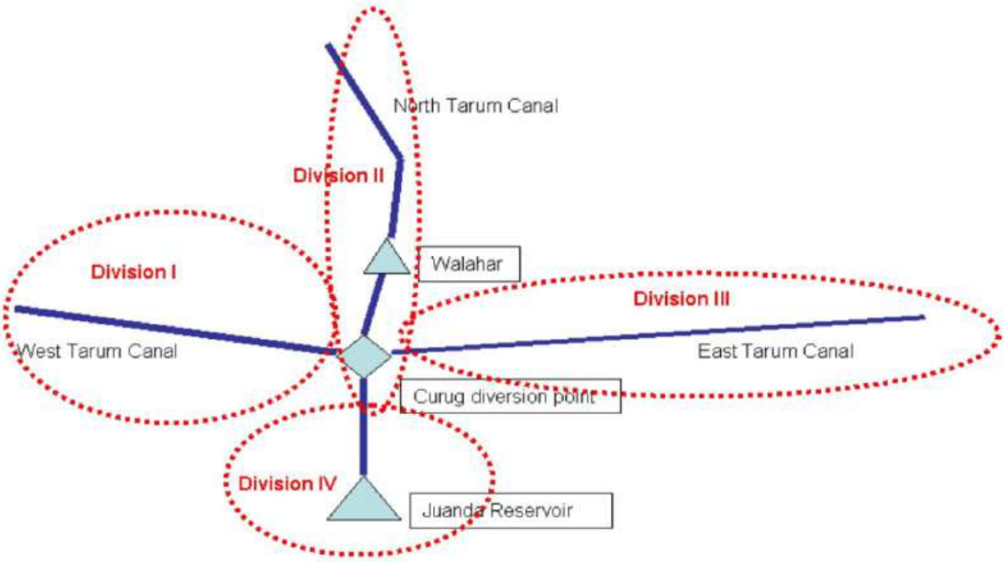
- Division I is responsible for operation and maintenance (O & M) of The West Tarum Canal (including supply to Jakarta Special Capital Region);
- Division II is responsible for The Curug diversion point, The Walahar Weir and The North Tarum Canal;
- Division III is responsible for operation and maintenance (O & M) of The East Tarum Canal;
- Division IV is responsible for the operation of The Djuanda Reservoir;
- Hydropower Division (PLTA) is responsible for electricity production.



Source: *Jasa Tirta II Public Corporation*

Figure 2. Schema of The Jatiluhur Irrigation System

The Divisions are divided into sections. The Staffs called Water Observers (Pengamat) are working in the sections, who overview the work of Water Masters (Juru Pengairan). PJT II is principally responsible for the operation & maintenance of the primary system. The operation of the secondary gates and tertiary intakes is conducted by the the Water Observers and Water Masters who are staff of PJT II. Maintenance of the secondary system and tertiary intakes are a shared responsibility between PJT II, Provincial Water Resources Department, Citarum Large River Basin Organization (Balai Besar Wilayah Sungai Citarum) and departments at district level.



Source: *Water Allocation Practices and Water Balance Jatiluhur, October 2010*

Figure 3. Simplified Management Organization of The Jatiluhur Irrigation System

3. YEARLY WATER ALLOCATION PLANNNING

Yearly water allocation planning follows by principle according to the procedure as describes in Figure 4. At district level the Observer (Pengamat) and Farmer Group (P3A/Kelompok Tani) make a prediction of the cropping plan for incoming year. The proposed cropping plan will be collected at regency level and subsequently at Provincial Irrigation Commission. The Irrigation Commission prepares a proposal for the Governor of West Java, which includes a description of proposed cropping intensity and so called "Golongan" (group) system.

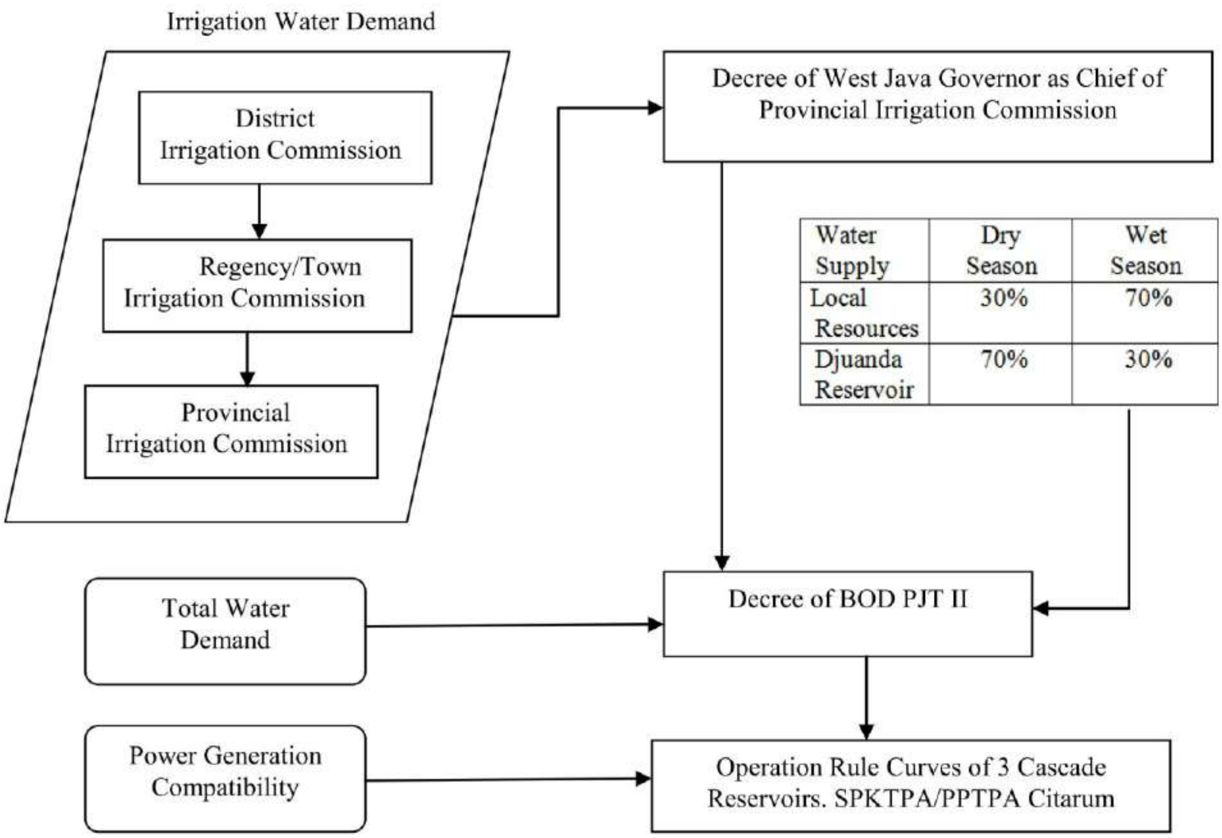


Figure 4. Annual Water Allocation Planning

In practice, the proposed cropping intensities are based on evaluation of previous years' experience. The Governor issues a Governor Decree every September in which the cropping intensities and Golongan (group) system are presented. This becomes input and reference for PJT II in order to calculate release schedules of yearly water demands.

3.1 Cropping plan-group (golongan)

The cropping plan applied in Jatiluhur is actually paddy-paddy-"palawija" (fruits and vegetables). The cropping intensity is slightly higher than 200%. The command area is fully cultivated with paddy for two seasons and some palawija in the third growing season. The group system is applied to balance the peak of water demand during initial of growing season. Another important objective is to avoid pests and diseases in the area threatening entire area, therefore planting intervals are used. In the Jatiluhur system five groups system with 15 days interval is applied. Table 1 presents the Governor Decree about group intervals for the cultivation season 2007/2008.

Table 1. Cultivation Season by Group 2007/2008

"Rendeng" Paddy Cropping, Cultivation Season 2007/2008	
Group I	Irrigated starting from October 1 2007
Group II	Irrigated starting from October 16 2007
Group III	Irrigated starting from November 1 2007
Group IV	Irrigated starting from November 16 2007
Group V	Irrigated starting from December 1 2007
"Gadu" Paddy Cropping, Cultivation Season 2008	
Group I	Irrigated starting from March 1 2008
Group II	Irrigated starting from March 16 2008
Group III	Irrigated starting from April 1 2008
Group IV	Irrigated starting from April 16 2008
Group V	Irrigated starting from May 1 2008

According to the same Governor Decree, the area proposed for palawija is located in the Group I and the Group II within area about 4,065 Ha. Actually in the field, most farmers begin to cultivate rice apart from the proposed group system. This has negative consequences for the water allocation schedule and need more research to find out better solutions.

3.1 Yearly Cropping plan-group (golongan)

Based on Governor Decree, PJT II calculates a water supply schedule. It comprises the irrigation water requirement, domestic municipal and industrial (DMI) water requirements and operational losses. Irrigation water requirements are calculated based on hectare (ha) and a standard demand about 1 l/s/ha. Canal losses are standard percentages. DMI water requirements are included in the water supply schedule:

- Water requirements for industry are based on an inventory of the licenses provided to the industry;
- The drinking water companies have a direct contract with PJT II about the supply of raw water. This is a constant demand (no seasonal variation).

The water supply schedule is ruled by Decree of BOD Perum Jasa Tirta II (PJT II) about *Rencana Pokok Penyediaan Air dan Penggunaan Air* (Main Plan of Water Provision and Water Utilization). The BOD Decree can be seen as guideline for water supply to the Jatiluhur irrigation system along one year. In practice, according to PJT II, the yearly allocated water quantity per ha paddy is 12,000 m^3/ha/season. According to their own estimates it is too high. Actual water requirement would be in the range of 6,000 – 8,000 m^3/ha/season. Effective rainfall is not considered in the calculation. In the past time, PJT II has experimented by allocating less water yet it has evoked farmers protest.

A simple calculation using Cropwat by FAO shows that during the dry season (starting April 1st), gross irrigation demand is about 11,000 m^3/ha (including 5,000 m^3/ha) for percolation losses and in the wet season (starting November 1st) the gross irrigation demand is about 5,500 m^3/ha. This last term includes the use of effective rainfall during the wet season.

4. COORDINATION AND MONITORING MEETINGS

At different levels coordination, meetings are always committed. Figure 5 presents coordination and monitoring activities between PJT II and the other parties. Every two weeks a coordination meeting (TEPASA) takes place which is attended by all division heads. The weekly meetings (*Rapat Minggon*) take place on section level at the field. The bi-monthly TEPASA meeting is attended by all the Divisions including Hydropower Division (PLTA) which is responsible for electricity production. Every division reports on water supply, daily releases and alterations, cropped area and status of the crops. Hydropower Division (PLTA) reports on release schedules and power generation. The required changes in water supply scheduling are discussed at this level. If extra discharges are required, then it is also discussed in this meeting. The input for the TEPASA meeting is generated by the activities of Water Observer (Pengamat) who is responsible to monitor field conditions. Weekly basis of field information is collected by the Water Observer (Pengamat) and processed through the sections and finally proceed to divisions. Figure 6 depicts the flow chart of entire undertaken procedure.

Monthly meeting (SPKTPA) is also performed and to be attended by PJT II, Citarum Large River Basin Organization (BBWSC), Provincial Water Resources Management Department, Meteorology Climatology and Geophysics Agency, cascade dams operators and other related state institution. The impression is the meeting is well organized and structured. The status of the three reservoirs is always reported, release schedule for the incoming weeks is also discussed. The current weather condition and upcoming prediction for two weeks period are discussed.

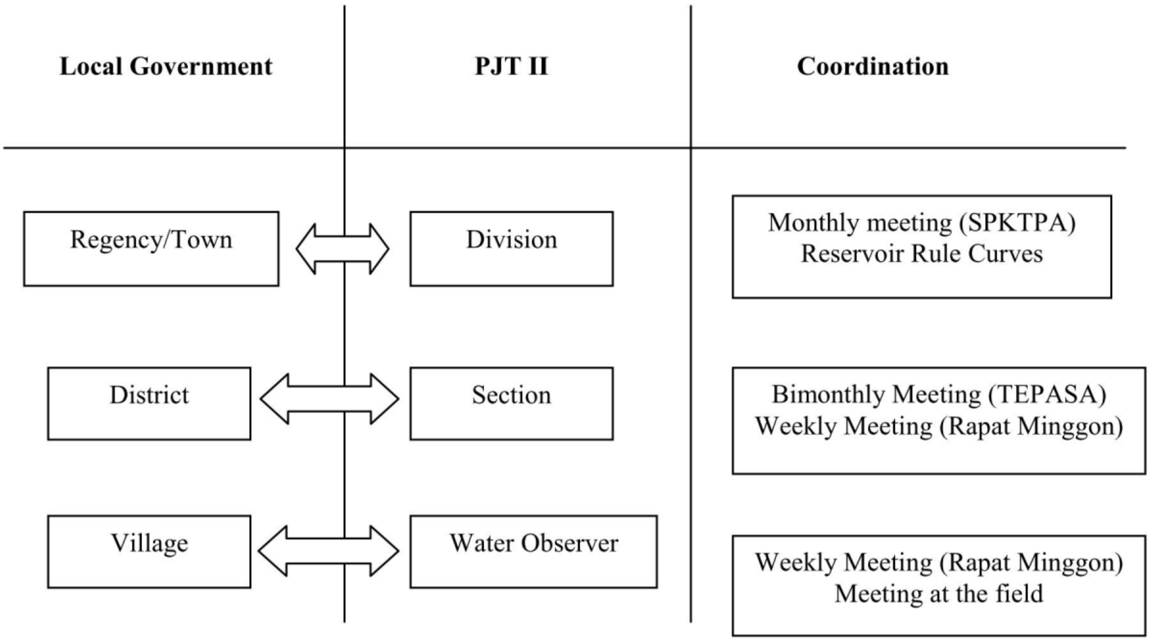
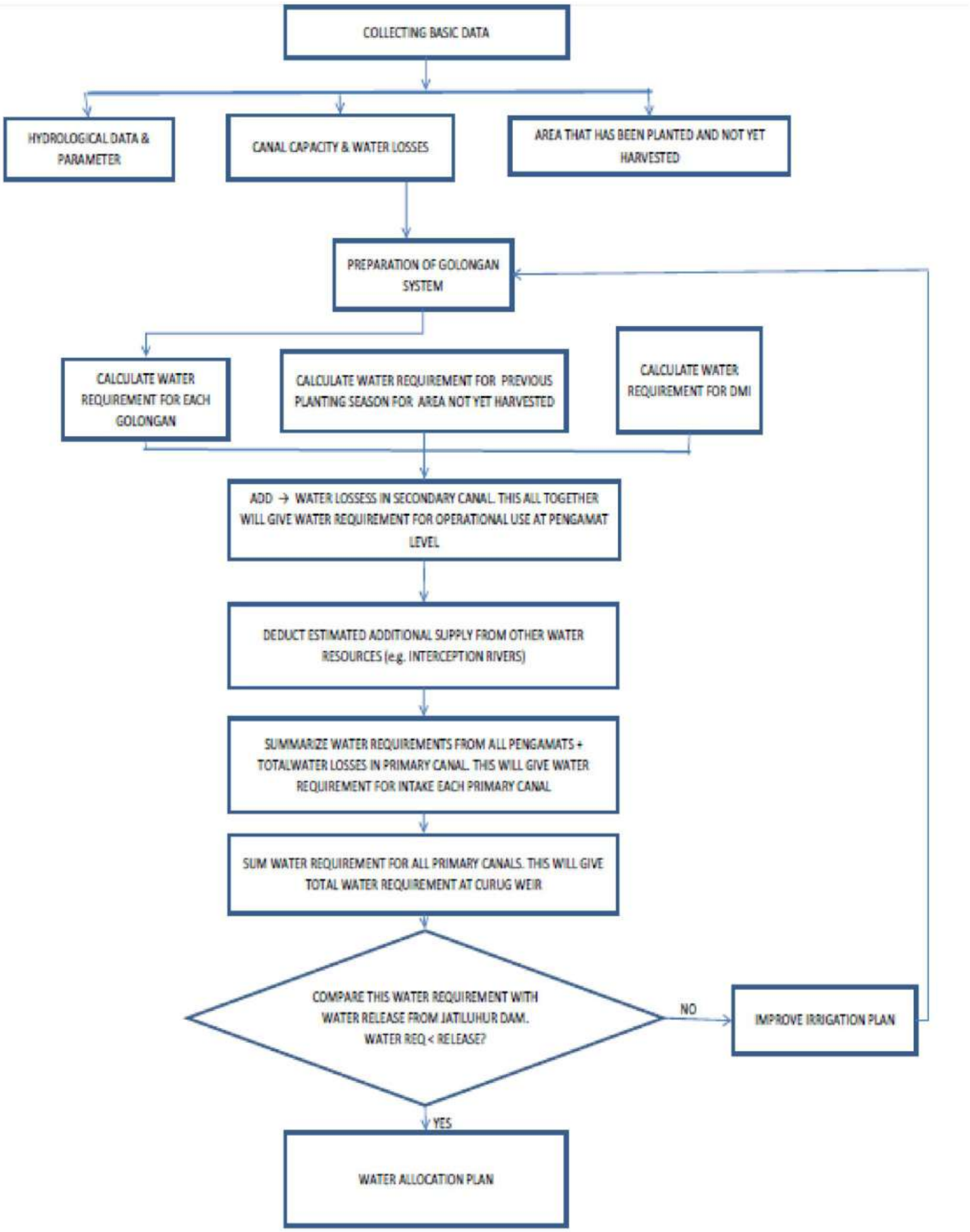


Figure 5. Weekly, bi-monthly and monthly meetings PJT II on water allocation and monitoring

5. WATER DISTRIBUTION INFRASTRUCTURE

Water is released from The Djuanda Reservoir and then diverted to The West Tarum Canal and The East Tarum Canal at The Curug Weir. The main flow is heading to the north direction reach to The Walahar Weir. The North Tarum Canal is supplied by water from The Walahar Weir. At three points in The West Tarum Canal discharges are daily monitored and reported. These are the intersecting rivers Cibeet, Cikarang and Bekasi. The rivers' water is diverted from temporary reservoirs to the main canal by building a weir installed with sliding gates to control the upstream water level. Besides of these three points, there are no other points in which discharges are monitored or regulated.

Most of remaining Romijn weirs are not operated and monitored. Sliding gates have replaced majority of the Romijn weirs, but are not well equipped with measurement devices. Operation in the field is thus largely dependent on experience and insight of the Water Observer (Pengamat) and Water Master (Juru Pengairan). The siding gates are operated based on discussions with farmers at the field and adjusted according to the field conditions. There is no quantitative measurement. When there is water shortage, a rotation schedule is managed by the Water Observer (Pengamat) in cooperation with P3A and farmer group (kelompok tani).



***Source:** Water Allocation Practices and Water Balance Jatiluhur, October 2010*

Figure 6. Process of water allocation planning

Based on DHV, et.al (2010), here are the conditions of water distribution infrastructure as follow:

1. Many Romijn irrigation off-takes have been replaced by sliding gates with a broad crested measuring weir downstream. It was further found that in some cases the measuring weirs were not modular.
2. Check structures in secondary canals are normally provided with stoplogs. No measuring devices have been installed at critical locations such as boundaries of service areas or group areas. Therefore, it is not possible to measure the flow in the downstream sections of the secondary canals.
3. Quality of the structures was often poor, concretes and lining showed serious cracks, making the structures in some cases unusable.
4. Many of the sub-secondary and tertiary irrigation off-takes were not operated properly; actual discharges were not measured; many Romijn off-takes were used as an undershot gate instead of an overflow gate; the broad crested weirs were not used; and most of the operation guideline boards (papan eksploitasi) were already disappeared.
5. The primary canals are clogged by heavy sedimentation.

6. WATER BALANCE AND CLIMITE CHANGE

The study predicts reduction on irrigation water demands from 4,290 Million m^3 annually in 2010 to 3,973 Million m^3 annually in 2025 based on dry year crop water requirement. The reduction is caused by land conversion (about 1% reduction per year) and the introduction of SRI farming which has a water saving effect. The water balance study is described in Table 2 including development of total water demand for the Jatiluhur system from 2010 until 2025.

The Future Domestic Municipal and Industrial (DMI) water demands were projected based on population growth and development of industrial area. The DMI water demands increase from 883 Million m^3 per year in 2010 to 2,135 Million m^3 per year in 2025. This is mainly originates from the Jakarta Metropolitan Area, where demand increases from 2010 to 2025 with about 1,000 Million m^3 per year. Total water demand for The East Tarum and The North Tarum Canal systems remains almost stable during the period of 2010 - 2025.

Table 2. Total Water Demand for Jatiluhur 2010-2025

Canal	Total Irrigation and DMI Water Demand (Million m³)											
	2010			2015			2020			2025		
	DMI	Irrigation	Total	DMI	Irrigation	Total	DMI	Irrigation	Total	DMI	Irrigation	Total
WTC	758	868	1,626	1,246	837	2,083	1,579	802	2,381	1,750	763	2,513
ETC	114	1,801	1,915	160	1,758	1,918	214	1,716	1,930	277	1,675	1,952
NTC	11	1,621	1,632	38	1,593	1,631	71	1,564	1,635	108	1,535	1,643
Total	883	4,290	5,173	1,444	4,188	5,632	1,864	4,082	5,946	2,135	3,973	6,108

Source: *Water Balance study for JIMIP, 2010*

Water availability includes from The Djuanda Reservoir and discharge of regulated rivers which forming a supplementary water resources to the system. The estimated water availability and water demand from 2010 to 2025 is presented in the following Table 3.

Table 3. Estimated Water Availability and Demand 2010-2025

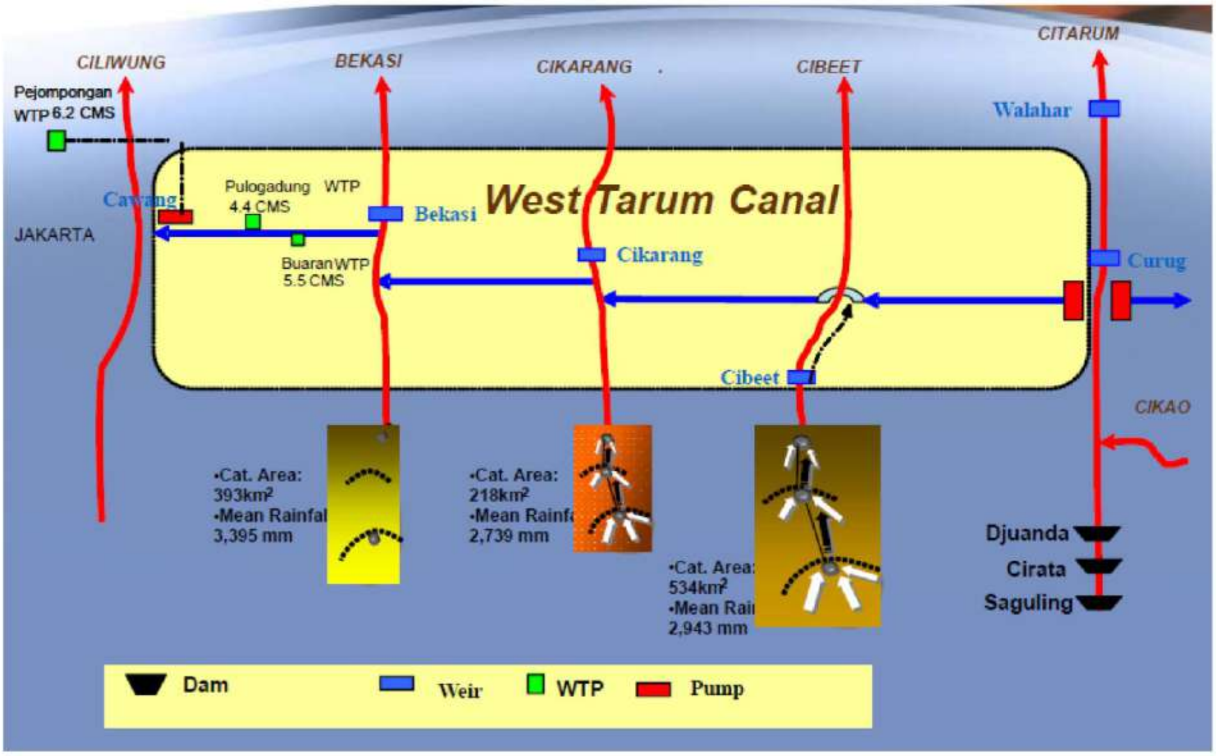
Year	Water Availability (Million m³/yr)			Water Demand (Million m³/yr)			Balance (Million m³/yr)
	Jatiluhur	Rivers (regulated)	Total	Irrigation	DMI	Total	
2010	5,344	2,096	7,440	4,290	883	5,173	2,267
2015	5,317	2,191	7,508	4,188	1,444	5,632	1,876
2020	5,291	2,216	7,507	4,082	1,864	5,946	1,561
2025	5,264	2,215	7,479	3,973	2,135	6,108	1,371

Source: *Water Balance study for JIMIP, 2010*

Based on the table, it is predicted that the annual water availability of The Djuanda Reservoir and discharge of regulated rivers remains quite stable. An interesting theoretical observation is that the annual water demand in 2010 (5,173 Million m^3) can still be met by The Djuanda Reservoir (5,344 Million m^3). However in 2025 the total water demands (6,108 Million m^3) exceeds the capacity of The Djuanda Reservoir (5,264 Million m^3). It means that in the future entire system will depend much more on water supply by regulated rivers. It assumes the water demand of DMI is constant in time and will not depend on seasonal variation. The entire system will be more sensitive in the future affected by climate change and related effects like changing rainfall patterns and river discharges.

The study shows that major changes will take place in the command area of The West Tarum Canal. Total water demand will increase from 1,626 Million m^3 in 2010 to 2,513 Million m^3 in 2025 including irrigation and DMI. The largest projected increase in water consumption will distinctly come from DMI. The water demand in The North and East Tarum Canal will remain quite stable in the same period. Future study should specifically focus on the command area of The West Tarum Canal. The West Tarum Canal receives water from The Curug Weir. At three locations, rivers intersect and deliver supplementary water to the canal by weirs then flowing to Jakarta Metropolitan Area. The three rivers are Cibeet, Cikarang and Bekasi. This situation can be illustrated in Figure 7. Average river discharges of the three interception rivers are presented in Figure 8. It is considered that critical period of May – July shows the average discharge of the three interception rivers drop drastically. This means that in this period, the irrigated area and the water supply rely almost completely on water released by The Djuanda Reservoir.

The study predicts that water availability from The Djuanda Reservoir remains stable. However, Figure 9 depicts that there is a negative trend in water releases from 1993 – 2008. The trend line suggests that from 1993 to 2008 water releases have declined by 30 percent. The question is what this negative trend will mean for 2025, whether it is continuing and thus reducing water availability of the reservoirs in the future. The third question is whether there is a correlation with rainfall in the upper watershed.



Source: *Jasa Tirta II Public Corporation, 2009*

Figure 7. Water Supply to The West Tarum Canal of Jatiluhur Irrigation Area

Answering the third question, Pawitan (2002) stated that there is a correlation between a decrease in rainfall in the upper watershed and the negative trend in water releases. It means increased pressure on water resources in the upper watershed can cause a negative impact on the water availability.

The water balance study focuses on annual averages and trends. The main point for improvement is to look at the variation of water availability in time (seasonal variation) and space (West Tarum Canal vs. East Tarum Canal and head–tail differences in the command area). In addition, the effects of climate change are not considered yet in the water balance. Based on GOI (2007), the rainfall pattern may turn due to climate change as is presented in Figure 10. In the future climate scenario, the dry season (musim kemarau) will be prolonged and rainfall will be more intense in a shorter period. The Overall cumulative annual rainfall may not change significantly but the seasonal distribution will be.

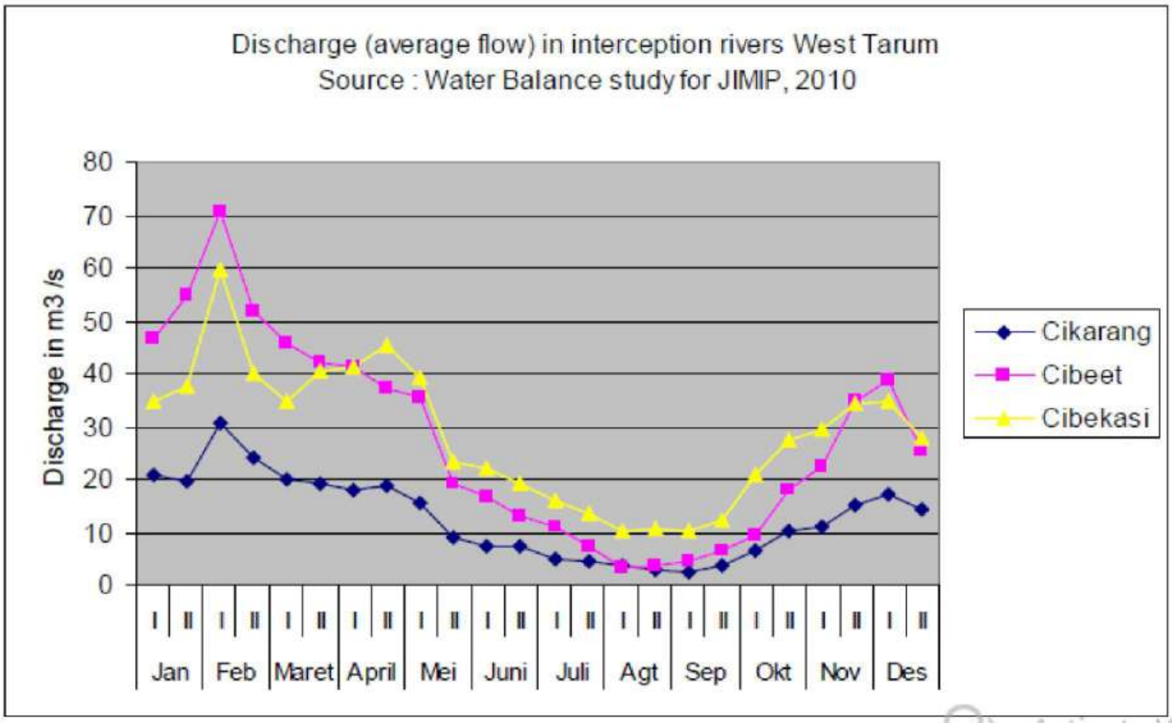


Figure 8. River discharges intercepted by The West Tarum Canal

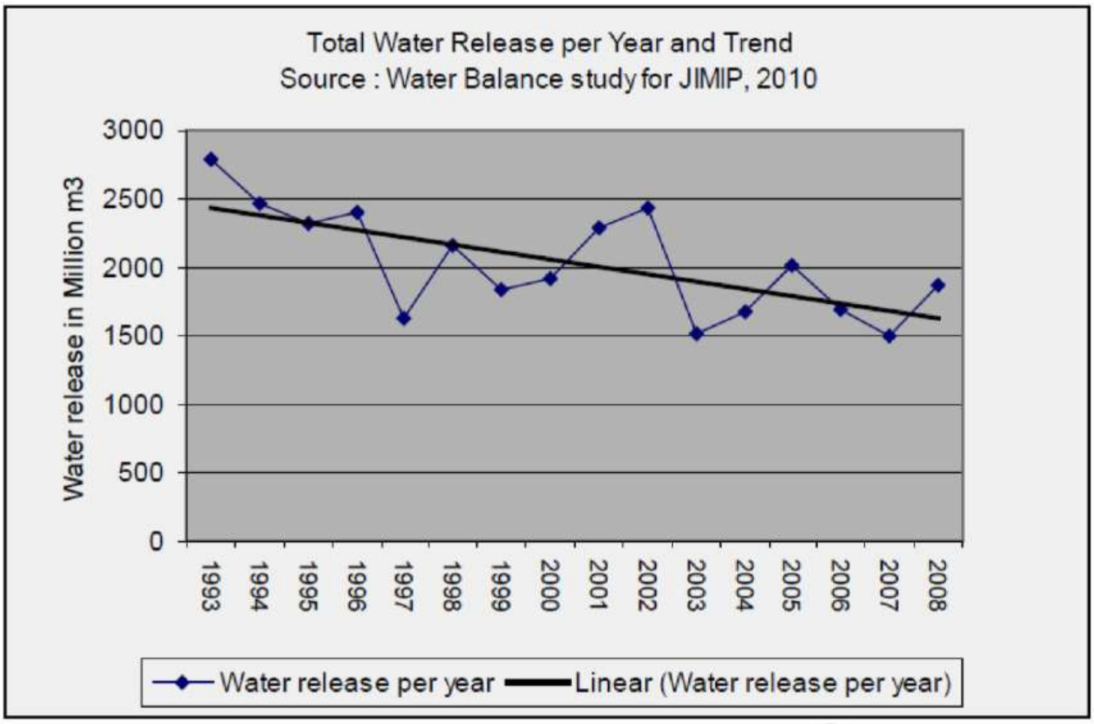


Figure 9. Annual water release from The Djuanda Reservoir

The water balance study does not take (yet) the effects of climate change into account. The current potential bottle-necks for the period May - July as identified above, may become much severe when current trends in climate change will prevail effectively. Water supply of irrigated agriculture and DMI is more vulnerable than as presented in the water balance study.

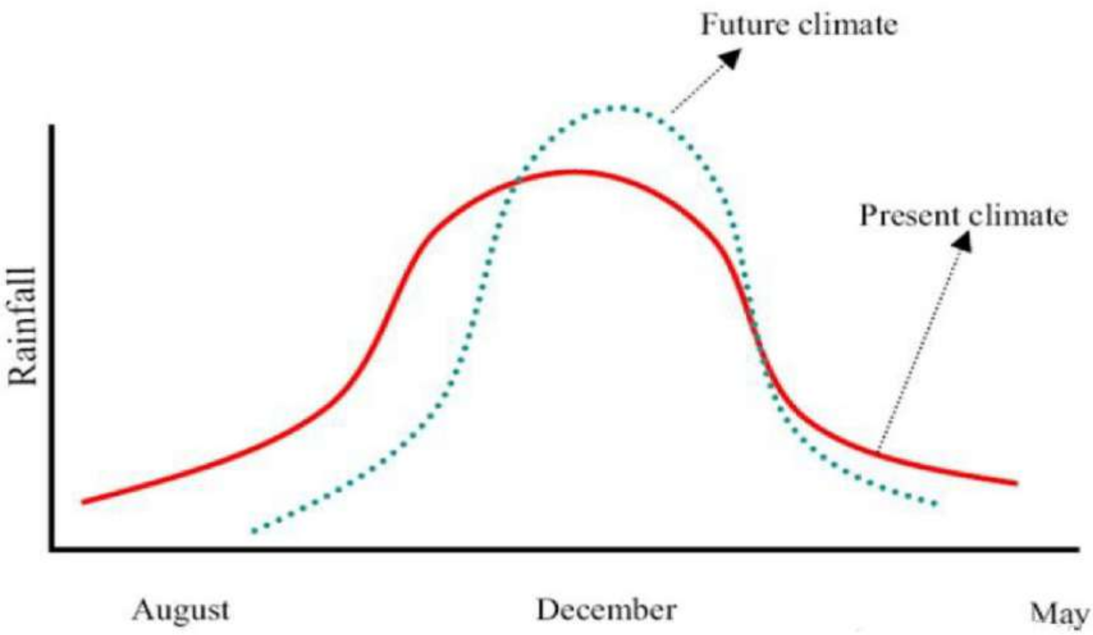


Figure 10. Changes in rainfall pattern

7. DISCUSSION

An important point for improvement is the quality and reliability of basic data required to prepare the water allocation plan and distribution schedule. As was presented before, actual data on land use, command area and water distribution is not reliable. In the last hundred years since 1900, the use of land in Java Island has undergone a change from forest area to agricultural land. This change has continued in the past three decades, with shifts from agricultural land to residential and industrial areas. These changes are the basis of the anthropogenic influences on the hydrological regime and carrying capacity (Pawitan, et al., 2011). Because land conversion (from agricultural land to urban and industrial use) takes place continuously there is a need to monitor field conditions more accurately. It can be expected that in the coming decade with the expansion of Jakarta Greater Area, land conversion will be a major factor in the command area of The West Tarum Canal.

The Jatiluhur irrigation system is mainly supply driven. Water distribution is mainly regulated and monitored at the main intake point at The Curug Weir. Downstream from The Curug Weir hardly any quantitative monitoring takes place except interception river in the main canal. Due to the poor conditions of the water distribution infrastructure, quantitative monitoring is in fact impossible in a major part of the irrigation system. Water distribution at secondary and tertiary level is implemented by Water Observer (Pengamat) and Water Master (Juru Pengairan) who basically based on experience operating the system.

A major point which needs consideration is that generally there is no shortage of water for irrigation in the command area. Water allocation for paddy is calculated based on 1 l/s/ha and rainfall is not included. Besides this, PJT II indicates that when occasionally water shortages occur (according to the farmers) they are able to release extra water. It means that there is currently no incentive to regulate water distribution more strictly. Commonly, we can see that irrigation systems in Central and East Java, there are more water shortages and as a consequence water allocation and distribution is controlled more intensively.

With regard to the free-riding farmers and the Golongan system it can be expected that the abundance of water available for paddy in the Jatiluhur is one of the underlying causes anymore. Water distribution efficiency can be improved by several means. However improvements should be identified based on reliable data. The major shortcoming problem on the current water management practices in the command area of Jatiluhur is a lack of reliable field data of discharges and the command area. First step in improving water distribution efficiency is the improvement of the current monitoring system. At every main canal at least three cross sections should be identified, which need to be upgraded and calibrated so that in three sections viz head, middle and tail discharges can be measured and monitored. With an extra check on the actual command areas it is possible to get a fairly accurate impression of the water distribution in the command area. Based on this data, calculations can be made with regard to irrigation efficiency, water distribution efficiency etc. Distinction between different sections can be more obvious (for example between head and tail).

Improved monitoring should be conducted for at least 1 or 2 seasons. Only by doing this some quantitative insight is gained on the surplus of system water availability. Based on this a more accurate analysis can be made about the water balance and the annual variations. Better informed decisions can be obtained to take actions also improve efficiency and infrastructure. Secondly, monitoring data concerning water supply and distribution of the irrigation system can be communicated to farmers in general. At this stage there is no need to extend the monitoring through all secondary intakes and tertiary intakes. At this level, operational decisions are made by the Water Observer (Pengamat) and Water Master (Juru Pengairan) based on information from farmers and years of experience. An extra investment to improve monitoring at this level will not be efficient without the necessary improvements at main system level.

8. CONCLUSIONS AND RECOMMENDATIONS

Based on the explanations above some conclusions can be obtained herein. The mechanisms for water allocation and distribution are well documented in guidelines and are professionally implemented by PJT II. At the moment there is no need to change these mechanisms. Current water allocation mechanisms and coordination meetings at primary level are working efficiently. Procedures are followed according to the guidelines. The main shortcoming problem is the quality of field data used for water allocation and coordination meetings. The water allocation and distribution is implemented effectively only at the diversion point of Curug Weir in the head of the system. Downstream course of The Curug Weir, water is distributed by using years of experience and discussion/negotiation between farmers and staff of PJT II. The overall water availability as well as regulated water availability in the Jatiluhur system can satisfy the total water demand in the Jatiluhur area up to the year of 2025 from the viewpoint of total demand and supply volume. The future projected water balance is not robust because: (a) there is a negative trend in water releases of The Djuanda Reservoir, with a possible correlation with decreased rainfall in the upper watershed of the Citarum; (b) developments in the upper watershed of Citarum are not accounted in the water balance study; (c) the monthly variations in water supply of The Djuanda Reservoir and interception rivers for the period of May - July can become critical bottle-necks; (d) the water balance does not (yet) take into account the potential negative effects of climate change on water availability. The points above indicate that when water availability is analyzed in time, there is still a really potential bottle-neck for irrigated agriculture in the command area of Jatiluhur and also domestic, municipal, and industrial water use mainly from Greater Jakarta Area.

Several recommendations can be proposed and should also be considered as follow. Improving the current water distribution monitoring system should be conducted at main canal level. By monitoring discharges at head, middle and tail of the primary canals a better analysis can be made about irrigation and water distribution efficiency. Better informed decisions can be made to make improvements in system management. A more in-depth analysis is required which focuses on the variation of water availability in time (seasonal variation) and in space (upper watershed, but also differences in the canal system). The case is clear that although water may be sufficiently available overall, PJT II, Citarum Large River Basin Organization (BBWS Citarum) and Provincial Water Resources Management Department (Dinas PSDA) should intend on increasing irrigation efficiency in the command area of Jatiluhur. Further study is required to investigate whether the negative trend in water releases from Jatiluhur really occurs and will continue up to 2025. Future developments in the upper watershed of the reservoir system must be taken into account. These may affect the water availability for the reservoir system and the downstream service area.

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