ABSTRACT

Being the world largest archipelago country, Indonesia with its 17,508 islands and isles, forms an integrated entity referred to as "Wawasan Nusantara" having a total land area of 1.92 million km², with abundant water resources potency of at least 17,000 km³ annually. Despite this abundance, the water resources availability is not properly distributed amongst the islands and geographical regions. Meanwhile, population distribution is also unbalanced having over 60% of the country's population are concentrated on Java Island alone, which is in fact, consisted only about 7% of the total land area of the country. The total water resources potency of Indonesia is estimated at about 2,530 km³, of which only about 2% (96 m³/capita/year) is currently utilized for different purposes. Out of the 2% of the current water utilization, about 76% is currently used for supporting agricultural activities, 13.5% for domestic water consumption, and 11.5% for industry. Water distribution by island for the most part is concentrated on three major islands. These are Sumatra, Kalimantan and West Papua Islands.

The issues of conjunctive use of surface and ground water with a special reference to JABOTABEK Metropolitan Area has been discussed in this paper with an intention to give a concrete example of the underlying issues, problems and perspectives of water resources in the urban areas together with alternative solutions to resolve the problems. The Jakarta Metropolitan Area, being the Capital City of the country, has been suffered from a number of problems associated with water resources allocation to meet the increasing demands of life in the area. From the point of view of administrative territory, the JABOTABEK area is located in three provinces, Jakarta Metropolitan, Banten, and West Java Province. The total land area is 6,784 km², inhabited by about 17 million peoples in 1990s. It is projected that the region will be inhabited by about 39 millions peoples by 2005. The water demand for supporting life of the people was recorded at about 43.6 m³/second in 1990s, and projected to be about 138 m³/second in 2025.

The water sources in 1990s were recorded that at least 70% of Jakarta Metropolitan together with industrial areas of JABOTABEK, are relying their water demands (about 21.44 m³/second) from surface and ground water. Out of this amount, about 85% or about 18.30 m³/second from ground water, and only 15% or about 3.11 m³/second from surface water. The impacts of excessive groundwater extraction are quite obvious: (1) Rapid draw down of ground water resources beyond the sustainable carrying capacity level; (2) Degradation of...
environment resulted from increasing sea-water intrusion as well as land subsidence; and (3) Occurrences of contamination on ground water storage, which has been threatening the reliability of ground water potential. On the other hand, the continuous degradation of surface water has also been increasingly the case in most of the areas. Meanwhile, competition between water and land for variety of purposes have also been hampering considerably.

In order to be able to maintain a reliable quality and quantity of the water resources, it is essential to establish a consistent effort for integrated water resources based on conjunctive use of surface water and ground water sources with special focus on appropriate management of water resources infrastructures, improvement of spatial planning coordination, institutional arrangement, human resources development, technology, as well as regulatory instrument and its consistent law enforcement.

Keywords: JABOTABEK; Water Resources Management; Surface Water; Ground Water; Conjunctive Use.

1. INTRODUCTION

Despite the fact that Indonesia has abundant water resources, with high intensity rainfall, the availability of surface and ground water is not evenly distributed. In some areas, the water resources distribution, currently suffers from unbalance between demands and supplies. The water availability on one side has been decreasing, while on the other; the water demands have increasingly been unmanageable. The increasingly limited water resources potential has even been worsened by the continuously decreasing quality. Further to this, the vast socio-economic development has resulted in the remarkable competition on water resources utilization, among others for irrigation, domestic, urban and industrial development as well as water demands for supporting other human needs and environment.

In Indonesia, there are about 5,590 main rivers, which are grouped into 90 river-territories or river administration (SWSs). Grouping into the 90 SWSs is based upon: hydrological, government administration and spatial planning (EO of the Minister of PW No.39/PRT, 1989: Figure 1.). Out of the 90 SWSs, 73 SWSs are located within one provincial administration, and hence the management authority is delegated to the Provincial Government administration, 15 inter-provincial SWSs are remained at the Central Government Authority, and two strategic SWSs are managed by state-owned corporation. Within the entire 90 SWSs there are 186 lakes, and reservoirs and lowland as well as swamp areas at the grand total of about 33.4 million ha.

The total potential water resources is estimated to be about 1.85 billion m³/year or about 10,300 m³/capita/year in 1990 and projected to be about 7,200 m³/capita/year in the year 2020. From the national water resources perspective, this magnitude is considered more than adequate, however, due to inappropriate distribution, some places on Java and in the

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2 While this paper is prepared, through the WATSAL Program, the present review of Law No. 11/1974 about Water Resources is now being in progress. Under the present Draft of Law in lieu of Law No. 11/1974, the river categories are divided into: (1) River basin which is located entirely within Regency/Municipality Administration, and hence under the management control of the Regency and Municipality concerned; (2) The inter-Regency/ Municipality river basin is the responsibility of Provincial Government to control; and (3) The Inter Provincial river basin is the responsibility of Central Government.

3 As a general illustration, the overall water resources potency in Indonesia is about 2,530 krm³, which is only currently being utilized at about 2% (96 m³/capita/year) – of which, 76% utilized for supporting agriculture; 13.5% for domestic consumption, 11.5% for industry. In the mean time, the water resources distribution by island consists of: (1) Sumatra 22.26%; (2) Java and Bali 7.85%; (3) Lesser Islands (Nusa Tenggara) 1.75%; (4) Kalimantan 31.62%; (5) Sulawesi 6.7%; (6) Maluku 2.62%; and (7) Papua at 27.20%.
densely populated Outer Islands have indicated problems on fulfilling the underlying demands as compared to the availability of water. Meanwhile, population distribution is also increasingly unbalanced having the fact that about 60% of the current 215 million people are concentrated on Java Island which is only consists of about 7% of the country’s land.

Today, the water resources policy in Indonesia is now being under review and adjusted with the current demand for policy reform. The basic principle of water resources development and management is still in line with Article 33 of the 1945’s Constitution which is stated that land, water and all properties contained there in are controlled by the State and should be utilized as at the optimum as possible for the prosperity of the people. Elaboration of this basic principle is exemplified in the Law No. 11/1974 Regarding Water Resources – The review of this Water Law, in fact, is also being in progress, including all the related Government Regulation such as PP No. 22/1982 about Water Management, PP No. 23/1982 about Irrigation, PP No. 29/1986 about environmental protection, PP No. 20/1990 about Water Pollution Control, PP No. 27/1991 about Low Lands/Swamps, and PP No. 35/1991 about Rivers – together with all the related technical guidance’s, manual and standards.

2. PROBLEMS AND CONSTRAINTS RELATED TO WATER RESOURCES

In general, the efforts for water resources utilization and protection in Indonesia, like many other countries in the world is also hampered by a number of problems and constraints, among others are:

- The increasing limitation of water resources availability, particularly on Java Island, which is currently hindered by the increasing magnitude of water crisis as indicated by Water Utilization Index that is currently more than [0.5] on the one side, and the lacking of appropriate protection, control, and conservation;

- Escalating acceleration of economic growth together with unmanageable rate of population growth, which is directly dictating excessive water utilization and environmental degradation. This matter has been brought about escalating inter-sectoral conflicts in water utilization, increasing of pollution as well as other detrimental consequences;

- Indifferent deployment of upper catchment area of the rivers such as land conversion into industrial and human settlement leading to the detrimental condition hydro-ecology, together with their unwanted consequences, and hence, deprivation of appropriate balance of water resources ecosystem.

- Injudicious exploitation of surface water and ground water sources lead to the acceleration of environmental degradation in addition to water related disasters such as flooding, droughts, and landslides, together with their related epidemics consequences.

2.1 Present Condition of River Catchment Areas:

Based on the data of the Directorate General of Water Resources, it has been identified a number of parameters indicating the underlying detrimental condition of the river catchment areas. This includes the present magnitude of water-use potential index (WUPI) at the magnitude of [\(>0.50\)] and “Coefficient of Variation” (CV) at the magnitude of [\(>0.40\)]. From these indications, it has been found that 41 river-catchments under the very critical condition, 55 river-catchments found to be critical, and 38 river-catchments under the least critical condition, but still demanding immediate attention.
2.2 Underlying State of Water Resource Vulnerability:

Based on the Ministry of Public Works and the Ministry of Mining and Energy (1995), it has been recognized that the underlying condition of water resources potential on Java and Bali Islands, both for surface and ground water, have been under the very critical condition due to excessive exploitation beyond the carrying capacity.

The limitation of water resources in some areas, have already brought about obvious consequences and adverse impacts on big cities, particularly on Java, such as Jakarta, Bandung and Surabaya. For illustration, the present exploitation of ground water for industrial purposes alone in Bandung had been recorded at 66.9 million m$^3$/year with its obvious impact to the drawdown of shallow aquifer (40–150m) or between 0.12 to 8.76 m per year, and for the deep aquifer (>150m) between 1.44 to 12.48 m per year. Meanwhile, condition of ground water in Jakarta has currently been under the very critical condition and brought about obvious impacts on land subsidence in some parts of the city such as in Cengkareng (near the airport), Grogo, Cempaka Putih and Cakung.

The critical ground water condition has been more and more distressing due to the detrimental impacts of seawater intrusion, which is currently occurred in several areas such as Jakarta, Cilegon – Banten, North Coast of Java, Bali and Medan (North Sumatra).

2.3 Present Condition of Water Quality

2.3.1 General Trend:

With the current population of about 215 million peoples, water demand potential in Indonesia, without sustainable integrated water resources management will be far-reaching and hardly materialized. Particularly on Java Island, with a total population exceeds 118 million peoples (889 person/km$^2$), this alone has already far beyond the average population density in Indonesia.

At present, the total volume of pollution load resulted from domestic waste alone, has already exceeded a magnitude of five million m$^3$/year. This figure is considered to be the major source of organic wastes, which is contributing at most to the fertility to the water environment and hence accelerating the growth of microbe on impounding water (lakes, ponds, reservoir and swamps).

Degradation of water quality at this moment in fact, is not only occurred at the downstream reach of the river, but already approaching the middle reach, even up to the upper reach of the river catchment. For example, the existence of Eschericacoli bacteria and coliform at the upper reach of Cimanuk River in West Java has been recorded at 43,000 to 24,000,000 MPN/100mL, while The Citarum River case, has indicated the magnitude at about 2,300,000 MPN/100mL.

In addition, agricultural activities and deforestation at the upper catchment also increasingly enhance erosion, to accelerate the formation of suspended solids (SS) and sedimentation at the water stream, lakes and reservoirs. At the same time, the residue of artificial fertilizer, compost and pesticides from agricultural activities would be washed out, transported to the water bodies, and subsequently worsen the water quality. For instance, at the Upper Catchment of Citarum Basin, the BOD has come up to the magnitude of about 162 mg/L. At the upper site of Saguling Reservoir in Citarum Basin, pollution load in 1998, was recorded at about 143 ton of BOD per day, and estimated to escalate to the magnitude of 265 ton BOD per day in 2025 (BWRP-1998) if no significant measures are to be pursued.
Industrial Sector also considers to be the main contributor of waste loads lead to the severe degradation of water quality. Record in 1990 indicated that industrial load had come up to about 250,000 ton/year and projected to be about 1,200 million ton/year in 2010.

2.3.2 Urban Water Quality:
The urban water qualities are mostly below the raw water standard for drinking water. Most of the water sources for urban areas are containing substances that are harmful to human health and do not meet the minimum allowable standard of the raw water at the intake point, among others: TDS, heavy metal, *coliform*, Cd, Cr, Cu, Pb and Ni.

Amongst the urban water sources from River (Category B) which were monitored, most of them were containing water quality parameters that exceed allowable standard, among others are: *coliform*, DO, NH$_3$-N, Cu, Zn, fenol, detergent, oil and fat (See Tabel 1.).

Tabel 1. General Evaluation of urban raw water quality for drinking water treatment plant

<table>
<thead>
<tr>
<th>No.</th>
<th>City</th>
<th>River</th>
<th>Parameters that are exceeding the allowable standard.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DKI Jakarta</td>
<td>Ciliwung</td>
<td><em>coliform</em>, DO, NH$_3$-N, Cu, Zn, fenol, detergent, oil and fat.</td>
</tr>
<tr>
<td>2</td>
<td>Bandung</td>
<td>Cikapundung</td>
<td><em>coliform</em>, NH$_3$-N, DO</td>
</tr>
<tr>
<td>3</td>
<td>Semarang</td>
<td>Kali Garang</td>
<td><em>coliform</em>, NH$_3$-N, DO</td>
</tr>
<tr>
<td>4</td>
<td>Surabaya</td>
<td>Kali Surabaya</td>
<td><em>coliform</em>, NH$_3$-N, DO, Cr, Cd, Pb</td>
</tr>
<tr>
<td>5</td>
<td>Palembang</td>
<td>Musi</td>
<td>NH$_3$-N, DO</td>
</tr>
<tr>
<td>6</td>
<td>Pekanbaru</td>
<td>Siak</td>
<td>NH$_3$-N, DO</td>
</tr>
<tr>
<td>7</td>
<td>Pontianak</td>
<td>Kapuas</td>
<td><em>coliform</em>, NH$_3$-N, DO</td>
</tr>
<tr>
<td>8</td>
<td>Manado</td>
<td>Tondano</td>
<td>NH$_3$-N, DO</td>
</tr>
<tr>
<td>9</td>
<td>Denpasar</td>
<td>Tukad Badung</td>
<td><em>coliform</em>, NH$_3$-N, DO</td>
</tr>
</tbody>
</table>

Source: Research Institute for Water Resources, 1998

In most densely populated areas, particularly on Java Island, the standard of raw water qualities have yet fulfilled (Nana T., 1998). Meanwhile, urban water quality degradation are worsening from time to time due to limitation of urban sanitation facilities, poor law enforcement on water quality, as well as the inappropriateness of water resources management.

3. THE JABOTABEK CASE

3.1. General Feature
The JABOTABEK Plain, which extends northwest of Java Island, occupies a total land area of 6,784 km$^2$. The plain is located within several government jurisdictions, Jakarta, Bogor, Tangerang, and Bekasi, from which the term of "JABOTABEK" is originated. The area altogether, through an exceptionally vast development, has been transformed into the greater
JABOTABEK Metropolitan Area -- Jakarta Metropolitan City is one of them (See Figure 2. General location map of JABOTABEK Area).

The Jakarta Metropolitan (DKI Jakarta) as the Capital City of Indonesia is a special provincial administration consists of five municipalities: Central, North, East, South and West Jakarta. The DKI Jakarta has an area of about 652 km$^2$ with a total population at about 8.2 million people (1990's census), estimated to be more than 10 million at the end of 2003. The average population growth is about 2.4% per year. The population growth outside Jakarta, in the BOTABEK Area, is much higher, about 4.1 to 6.4%. It is estimated based on the above growth figure that within three decades the population of the Jabotabek area may reach about 39 million people (See Table 2. Population Projection).

<table>
<thead>
<tr>
<th>ADMINISTRATIVE AREA</th>
<th>YEAR (1990)</th>
<th>POPULATION PROJECTION IN 2025</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SCENARIO A</td>
</tr>
<tr>
<td>DKI Jakarta</td>
<td>8,207,000</td>
<td>12,902,000</td>
</tr>
<tr>
<td>Bogor</td>
<td>3,949,000</td>
<td>11,841,000</td>
</tr>
<tr>
<td>Tangerang</td>
<td>2,724,000</td>
<td>8,167,000</td>
</tr>
<tr>
<td>Bekasi</td>
<td>2,073,000</td>
<td>5,909,000</td>
</tr>
<tr>
<td>TOTAL</td>
<td>16,953,000</td>
<td>38,819,000</td>
</tr>
</tbody>
</table>


Table 2. Population projection of JABOTABEK area in 2025
3.2. Water Resources Potential and Availability

To provide sufficient amounts of water for a rapidly developing population, the area of DKI Jakarta Metropolitan must rely on both surface water and ground resources within as well as outside its administrative territories. On the eastern part of Jabotabek, the Citarum River, releases from the Jatiluhur Reservoir, is its main source of water. On the southern and western reach of JABOTABEK, the river systems of Cisadane, Cidurian and Ciujung are important sources of water. Considering the hydro-geographical characteristic of the Jabotabek Plain, the total land area of 6,6784 km\(^2\) is supported directly by three major river basin systems. These are Ciujung-Cidurian, Ciliwung-Cisadane, and Citarum river basins, covering about 7%, 85%, and 7% of the entire JABOTABEK land area respectively.

Based on the computer analysis of the JWRM study, it revealed that after the construction of certain hydraulic infrastructures, it is expected that the river system would provide potential raw water supply for municipal and industrial users at about 33 m\(^3\)/second from Ciujung Basin, 14 m\(^3\)/second from Cidurian Basin, 14 m\(^3\)/second from Cisadane Basin, 3 m\(^3\)/second from Ciliwung Basin, 6 m\(^3\)/second from Bekasi Basin, and 95 m\(^3\)/second from Citarum Basin.

The total water resources potential of JABOTABEK is estimated at about 71.5 m\(^3\)/sec., which is still potentially expandable up to about 155m\(^3\)/second. At this moment, however, the main water source of the eastern part of JABOTABEK is from the reservoir system of Citarum River (Jatiluhur, Cirata, and Saguling). At present, the water supply from Jatiluhur Reservoir through the “West Tarum Canal” is 16.1 m\(^3\)/second (for Pejompongan, Pulogadung and Buaran Treatment Plants). The eastern and southern parts of JABOTABEK rely their water sources from Cisadane, Cidurian and Ciujung River Systems. The future water resources potential for supporting the western parts of JABOTABEK is expected to come from Ciujung River system with the prospective Karian Dam (31m\(^3\)/sec), Pasir Kopo Dam (7m\(^3\)/sec), and Bojongmanik Dam (2m\(^3\)/sec).

The problems of water sources in the JABOTABEK are much related to the expansion of urban and industrial areas utilizing the fertile irrigated agricultural areas. As a result, the conflicting demands amongst agriculture, industrial and municipal water are increasingly the case.

Ground water resources have been developed heavily in the northern areas of Jakarta, Tangerang and Bekasi. Although the total volumes are relatively small compared to the overall water consumption. The ground water resources has a great socio-economic importance due to the fact that about 70% of the urban population of Jakarta depends on this water source. In 1990, for example, the ground water utilization is estimated at about 15.5 m\(^3\)/second, which was supplied at 8.9 m\(^3\)/second for domestic, 3.6m\(^3\)/second for commercial sector and 3m\(^3\)/second for industry. This implies that too much groundwater has been abstracted and land subsidence has occurred in several parts of the coastal areas. Despite this evidence, it is apparent that the ground water source cannot be ignored completely. In order to prevent the ground water of JABOTABEK from over extraction, it is essential that these issues must be tackled sensibly through a conjunctive use of surface and ground water management. The challenge of water resources planning is then how to implement conjunctive use in such a way to be able to maintain the optimum balance, within a realistic administrative, institutional and socio-economic framework, and within logical framework of hydrological entities.
3.3. Water Resources Planning Aspects For JABOTABEK

The current socio-economic developments in JABOTABEK has obviously generate escalation of urban and industrial water demands. At present, about 30% of the population of Jakarta rely on piped water supply as provided by PAM Jaya (Public Water Company of Jakarta). The rest of the water demands are abstracted from the local ground water aquifers. Since ground water tables have already been lowering considerably, plans have to be developed to increase supplies from surface water sources by virtue of conjunctive use. In addition, the ongoing pollution of the water resources demanding also sustainable water quality management in overall water resources planning. Most importantly, the water resources planning should include guidelines for flood mitigation and their negative effects.

For the planning purpose, the water demand sectors that have been considered are agriculture, households, offices, hotels, services, industries, urban flushing and maintenance flow as well as aquaculture and hydropower. Despite the urgency for urban flushing, it is too costly to provide special water supply effort for this use. Nevertheless, special attention must be set up to prevent the negative impacts on on environment from happening. There are only two major water demand groups that are currently prioritized. These are irrigation and municipal as well as industrial (households, offices, services, and industries).

**Irrigation water demand:** Due to the increasing urbanization, the demand for agricultural product will shift from paddy-to paddy pattern to horticulture and fruits. As a result a reduction of total water demand for irrigation is expected from 213 m$^3$/second in 1990 to about 189 m$^3$/second in 2025. The balance of this will be utilized for raw water supply for non-agricultural user groups.

**Domestic water demand:** For domestic water uses, the water demands are planned based on three income groups (high = 20% of the total population, medium rate = 40% and low = 40%). The demand per person for the three-income group was assigned at 200 l/d, 150 l/d, and 100 l/d respectively.

**Commercial and Service sector water demand:** So far, very few information about commercial and service sectors are available, the estimation of water demands have been assumed on the basis of household demand. Accordingly, it is necessary to rectify the assumption in such a way that there would be a direct relationship between the number of people living in the area and the activity levels of the commercial and service sectors.

**Industrial water demand:** Determination of industrial water demand was set up based on the average unit rate of employee in the manufacturing sector versus total projected population within the industrial area.

3.3.1 Water Demands Scenario

In order to arrive to the best long-term strategy for water supply for JABOTABEK, it is obvious that the future demands should properly meet the supplies. In connection with this predisposition, the water demand patterns have been evaluated by employing a scenario approach, while the available supply is derived from an analysis of the available water resources within and/or around the JABOTABEK area including some infra-structural measures that have already been foreseen.

For planning scenario the entire JABOTABEK area is divided into demand zones, so to enable to determine the magnitude of planning parameters. The DKI Jakarta Metropolitan consists of two zones, Bogor consists of seven zones, and Bekasi with three zones (see Figure 3. for Demand Zones).
The water demands for JABOTABEK are generated by various user groups and functions, including the Municipal and Industrial Sector (industries, households, offices and hotels), the agricultural sector, hydropower generation, aqua-culture and urban flushing. In order to estimate the municipal and industrial water demands, a prognosis has been made on the basis of the expected population in the project area and of the water demand per person. For this reason three alternative-scenarios have been designed, based on different economic development and governmental involvement assumptions. These scenarios are:

**Scenario A:** Continued with high economic growth, low administrative management input resulting in strong dependence on ground water, moderate increase in irrigation intensity and 10% reduction of irrigation water demand.

**Scenario B:** Low economic growth and low administrative management input resulting in strong dependence on ground water, low increase in irrigation intensity and small reduction of irrigation water demand.

**Scenario C:** Continued with high economic growth, high administrative management input resulting in minimum use of ground water and maximum use of piped water, strong increase in irrigation intensity and 5% reduction of irrigation water demand.

The appropriate combination of different scenarios for water demand with supply alternatives leads to a number of strategies, of which one has been selected as the most promising ones. The calculated water demands in the Jabotabek area for the different scenarios are presented in Table 3.

Based on these scenarios the number of population that is expected to live in the Jabotabek area has been estimated for different target years up until 2025. The total number of population does not differ much between the three scenarios, but the spatial distribution of the population does. As a result of various factors, an important of which is the process of urbanization, the M&I piped water demands vary considerably between the three scenarios.
Irrigation (m$^3$/second) | RESULT OF DEMAND ANALYSIS
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1990</td>
<td>Scenario A</td>
<td>Scenario B</td>
</tr>
<tr>
<td>---------------------</td>
<td>------</td>
<td>------------</td>
<td>------------</td>
</tr>
<tr>
<td></td>
<td>213</td>
<td>186</td>
<td>191</td>
</tr>
</tbody>
</table>

M&I (Domestic + Service & Commercial + Industry + In-plant losses + Unaccounted) m$^3$/second

<table>
<thead>
<tr>
<th>SCENARIO</th>
<th>1990</th>
<th>Scenario A</th>
<th>Scenario B</th>
<th>Scenario C</th>
</tr>
</thead>
<tbody>
<tr>
<td>DKI - Jakarta</td>
<td>44.2</td>
<td>55.2</td>
<td>18.2</td>
<td>10.1</td>
</tr>
<tr>
<td>Bogor</td>
<td>33.3</td>
<td>31.8</td>
<td>19</td>
<td>11.5</td>
</tr>
<tr>
<td>Tangerang</td>
<td>24.0</td>
<td>30.6</td>
<td>11.5</td>
<td>8.4</td>
</tr>
<tr>
<td>Bekasi</td>
<td>17.8</td>
<td>23.5</td>
<td>9.2</td>
<td>7.3</td>
</tr>
<tr>
<td>*Jabotabek</td>
<td>119.3</td>
<td>138.1</td>
<td>58</td>
<td>37.3</td>
</tr>
<tr>
<td>Serang</td>
<td>20.1</td>
<td>22.6</td>
<td>8.3</td>
<td>5.3</td>
</tr>
<tr>
<td>Krawang - Purwakarta</td>
<td>20.7</td>
<td>23.7</td>
<td>9.7</td>
<td>5.6</td>
</tr>
<tr>
<td>*The Study Area</td>
<td>160.1</td>
<td>184.4</td>
<td>76</td>
<td>48.2</td>
</tr>
</tbody>
</table>

Table 3. Water demand analyses of the JABOTABEK region, based on different scenarios

Especially for scenario C, where high economic expectations are combined with stimulation of the use piped surface water instead of ground water, the M&I demands are relatively very high.

Agricultural water demands are expected to reduce for a number of reasons, first of all to give allowance to expanding urban and industrial areas, secondly since it is expected that farmers will change to growing other crops that require less water, especially in the vicinity of the urban centers. Based on these assumptions, as well as those for water required for fish pond or tambak areas, for flushing and for hydropower, total water demands can be estimated. In order to meet these demands a number of supply alternatives have been developed. Priorities have been formulated as follows:

- Highest priority is given to existing irrigation and municipal and industrial water users;
- Next priority is given new developments in the municipal and industrial sector;
- After that, priority is given to new irrigation areas;
- Aqua-culture is considered to have less priority than new irrigation areas, since fish pond (tambaks) are located down-stream, and as such rely mainly on return flows from irrigated areas;
- Urban flushing has lower priority than aqua-culture, moreover urban flushing presently takes place naturally during the wet season;
• Hydropower has the lowest priority. In general, hydropower projects in Indonesia are only considered feasible if these projects are beneficial for other users or functions.

3.3.2 Water Supply & Demand Analysis
The water sources that are considered for the Jabotabek area consist of: (1) Treated surface-water to be used by households, offices, hotels and some industries; (2) Untreated surface water for some industrial functions like cooling and cleaning; (3) Groundwater that is used in general for the same purposes as treated surface water. Each of these sources of water has been incorporated in the various water supply strategies.

The objective of the different supply strategies that have been applied for the Jabotabek area are characterized as follows:
• Minimum investment strategies. This is a selection of supply options that can meet the water demands with a minimum of investment costs.
• Balanced water supply to the JABOTABEK area. This scenario is based on the consideration that for various reasons a large metropolis like JABOTABEK should not depend on a single source water supply, such as the West Tarum canal, instead, should balance it's water resources including conjunctive use with ground water.
• Reservation of the water of the prospective Karian reservoir for future developments in the western demand zones of Jabotabek, rather than relying on this source for supplying water to the central areas. This scenario is based on the assumption that the rapidly expanding western areas of Jabotabek have fewer options for future water resources development than the other parts of JABOTABEK.
• Safe drinking water strategy, in which greater consideration is given to water pollution risks and safeguarding the quality of future water supply to municipal and industrial water users.
• A multi-objective strategy has been developed, which includes several attractive-elements of the previous four strategies.
• The water demands that have been estimated for the three scenarios have been matched with these five different strategies. For each of these combinations the cost for related infrastructural works have been calculated and a strategy analysis has been carried out for the best alternatives.

3.3.3 Conjunctive Use Scenario
As previously stated, the strategy of water provision for the JABOTABEK AREA will be based on the promotion of infrastructure development followed by appropriate integrated water resources management. There are several alternatives have been put into consideration (JWRMS, 1994), among others:
1. Development of new reservoirs in the western part of Jakarta, within the area of Ciujuang-Cidurian River Basin, namely: Karian Reservoir, Pasir Kopo, Cilawang, Tanjung, which will have to be implemented in line with the construction of Karian-Serpong Canal, to convey water from Karian Reservoir and the rest to Serpong and Jakarta areas;
2. Construction of some reservoirs in the Eastern Region;
3. Increasing the storage capacity of Cirata Reservoir at Citarum Basin,
4. Construction of Tarum Jaya Canal (Canal Two), to convey water from Jatiluhur Reservoir at the Citarum Basin, directly to Jakarta.

In line with the improvement of strategy for water resources management implementation, it is urgent to consider a number of efforts to anticipate the associated problems and constraints, both related with technology and institution as well related to
human resources. One of the crucial problems is currently related to the capacity to generate funds for supporting operation and maintenance activities. Meanwhile, the water use efficiency for both supply for irrigation and piped water are still far from expectation. For the long-term perspective, it is obvious that the effort to improve the water supply efficiency is highly important.

From the best optimum choices available at the development scenario, it is projected that at the third decade to come, approaching the Year 2025, the domestic water demand for JABOTABEK would come up to about 67.5 m$^3$/second, at which the proportion of ground water should be restricted in such a way that it would not bring about undesirable impacts to environmental stability. It is advocated that maximum contribution of ground water should be constrained to the maximum of 43% of the overall water demand or about 28.9 m$^3$/second (See Table 3)$^4$, at the same time, and the proportion of surface water should be increased to about 57% or about 38.6 m$^3$/second.

The water demands for domestic and industries together in 2025 is projected to come up to about 138.1 m$^3$/second, and expected to have it supplied from ground water at about 27% or about 37.3 m$^3$/second, while the rest will be supplied from surface water that is obtainable from Citarum Basin in the East and Ciujung-Cidurian Basin from the Western of JABOTABEK Region (See Figure 4., and Figure 5.)$^5$

In connection with conjunctive use water resources management strategy, particularly for limiting the ground water extraction, a number of development alternatives are advocated:

1. The water supply priority by Public Water Company should be given only to the areas where the ground water quality are not supporting the appropriate uses, and also for the areas having indication of being affected by land subsidence.
2. The ground water pumping must be regulated by means of appropriate licensing system, which is suggested to be incorporated with construction license (building permit).
3. For the areas that have been provided with access to piped water by the Public Water Company, the use of ground water should be highly restricted, and compulsory water use form piped water should be applied.
4. Ground water tariff should be regulated and control in such a way that it comes up with higher rate as compared to surface water tariff.
5. To allow appropriate regulation of water, it is suggested that ground water management should be under one authority with surface water management, and must be separated with the Public Water Supply Company.

$^4$ The optimum ground water supply — was based on the prevention of negative water balance — recommended by the JWRMS for 2025, at which the water supply infrastructures had already been constructed, the capacity at: Serang 5.3 m$^3$/second; Tangerang 8.4 m$^3$/second; Jakarta Metropolitan 10.1 m$^3$/second, Bekasi 7.3 m$^3$/second; Karawang-Purwakarta 5.6 m$^3$/second; and Bogor 11.5 m$^3$/second.

$^5$ From the optimum alternative Alternatif C. JWRM, water resources demands for JABOTABEK area Projected to 2025 for Serang, Tangerang Jakarta, Bekasi and Karawang-Purwakarta, as well as Bogor areas are: 17.3 m$^3$/second; 22.2 m$^3$/second; 42.1 m$^3$/second; 16.2 m$^3$/second, 18.1 m$^3$/second, and 19.5 m$^3$/second respectively. These water demands are recommended to be supplied from a number of sources namely: from the Western Region (Pasir Kopo Reservoir and springs from the vicinity areas at about 7 and m$^3$/second respectively; Karian Reservoir at 15 m$^3$/second; Cilawang Reservoir and springs at the vicinity areas at 4 and m$^3$/second respectively); From Central Region (Salak Contour canal at 2 m$^3$/second; Genteng Reservoir and springs at the vicinity areas at 6.5 and 1.5 m$^3$/second respectively; Ciliwung Canal Supply and springs in the vicinity areas at 1.00 and 0.4 m$^3$/second respectively); and from Eastern Region (Jatiluhur Reservoir at 50 m$^3$/second, and supply improvement at 40 m$^3$/second.)

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4. CONCLUSIONS

From the National water resources perspective, Indonesia is considered to possess more than adequate water resources potency and up to this moment only very little proportion is currently being utilized. Nevertheless, distribution by island is not properly balanced. Population concentration on Java Island with high growth rate, contribute the most significant un-balanced between supply and demand.

For Java Island, the JABOTABEK Area – which is constituted as the Center of Growth and hence the reference bench mark (parameter) of national economic growth – constraints and problems as stated above are exceptionally difficult to solve. Considering the trend of population growth of the hinterland areas of Jakarta Metropolitan such as Serang, JABOTABEK and Purwakarta, it is projected that by 2020 these areas would be inhabited by about 50 million people or about 20% of the 250 million peoples in Indonesia, as projected by then. Therefore, the JABOTABEK and its neighboring vicinities would be the strategic center of economic growth, trade as well as industries of Indonesia. Recognizing this prospective trend, and considering the foremost importance of water resources for supporting the strategic activities stated above, it is apparent that there remain no alternative but to foster institutional arrangement for integrated water resources management – including conjunctive use of surface and ground water resources.

Considering the context of provision of adequate water supplies for supporting national economic growth, the JABOTABEK and the vicinity areas are grieving for urgent development for provision of water resources infrastructures together with their related management for additional reservoirs, ponds, or regulatory dams within three river basins: Citarum, Ciliwung-Cisadane and Ciliman-Cidurian. For these purposes, the alternative of mobilizing private investment as well as community participation on the provision of such water resources infrastructures should not be overlooked.

Bearing in mind that the river basins that are influential to the JABOTABEK are located within three provincial government administrations -- Banten, West Java and DKI Jakarta itself, therefore, the follow up development and management of river basin are highly demanding for inter-provincial institutional coordination such as “Water Management Committee”. In this context, the role of JABOTABEK Board of Coordination (BKSP) that has long been established could be extended toward certain capacity for coordinating programming activities related to the development and management of water resources – including pollution control, flood management, water conservation and drought management.

5. CLOSING REMARKS

Taking into consideration of the underlying activities on the development and management of water resources within the JABOTABEK Area, it is obvious that the water resources issue have indeed approaching the unavoidable urgency to address. In an attempt to provoke further discussions on the issues of conjunctive use based water resources development and management, the following remarks are worth considering:

1. There is an urgent need to immediately implement a short-term water resources development and management within the JABOTABEK and the vicinity areas by virtue of utilizing the best available potencies while encouraging public awareness and participation for following up efforts and commitment in the short-term, intermediate and long-term development and management of water resources.
2. Licensing and regulating both the supply and demand, among others by implementing tariff instrument with consistent surveillance and evaluation – by a special sort of professional authority, should immediately follow the use of ground water resources.

3. It is highly essential to continuously promote piped water distribution services, followed by a consistent endeavor to regulate or to control the extraction of ground water at the areas that have been provided with access to piped water distribution services.

4. Implementation of policy instrument on the provision of piped water and sewerage infrastructures by considering the capacity to recover investment partially or fully -- on participatory principles -- and eventually is instrumental to materializing appropriate balance between supply and demand of water resources.

5. There is an urgent requirement for optimization of excessive water use practices on agriculture – including the effective application of reuse and recycling techniques – so as the surplus water can be shifted to meet the urban or industrial water demands.

6. needs to be optimized in such a manner that the water scarcity frequencies be minimized. Therefore The design standard, the risk of recurrent drought incidences will be minimized.

7. Fostering the optimum implementation of spatial planning -- which is based on judiciously and cautiously considered all of the influential factors on water resources management -- including identification of specific locality that requires much water and level of consumption, identification of potential occurrence of land conversion, identification of location that potentially produce hazardous industrial wastes, etc.

8. Implementation of pollution control through provision of physical infrastructures as well as regulatory and supervisory instruments and consistent law enforcement on pollution control.

9. Effective coordination and interagency cooperation amongst stakeholders, through appropriate institutional arrangement, or Inter-agency committee on water resources development and management for inter-provincial river basin. In this context, the Provincial Government of Banten, West Java, and DKI Jakarta are required to activate the existing Board of Coordination, and establish technical working team to coordinate the activities of the Provincial Water Resources Committee for programming and implementation of integrated water resources development and management within the JABOTABEK territories.

10. In an attempt to encourage private sector investment on water sector development, it is essential to create a conducive, transparent and secure working atmosphere, particularly for provision of raw water and wastes-water treatment. Services.

11. It is imperative to give thought for establishment of some kind of Implementing Body for Water Resources Management within river basins the JABOTABEK areas -- Citarum, Ciliwung-Cisadane, and Ciujung-Cidurian basins. The main tasks of this executing body are: implementation of water resources allocation; monitoring and evaluation of water resources utilization on real time basis; flood control; pollution and drought management; implementation of tariff structures; management of water licensing; provision of information services for private and community; and investment opportunity on water sector.

Jakarta, October 2003.
BIOGRAPHY:

- Mr. Hafted Gany was born in Watan Soppeng, South Sulawesi, Indonesia, on November 10, 1944. In 1979, he obtained M.Sc. degree from the University of Southampton, U.K. In 1993 he obtained an interdisciplinary Ph.D. majoring Engineering, Economics, Sociology, and Demography at the University of Manitoba, Canada.

- From 1995 to 1999, he had been assigned as the Director of Water Resources Management and Conservation, DGWRD; Secretary General of the Indonesian National Committee of International Commission of Irrigation and Drainage 1993-2001; President of the Indonesian Chapter of INPIM 1996 till present; The Indonesian Committee Members for Professional Civil Engineers' Assessor since 1995. 1999-2000 as The Executive Secretary to the Directorate General of Water Resources, Ministry of Public Works; 2000-2001, Assistant to Deputy of Water Resources, State Minister of Public Works; 2001-2002 Director of The Research Institute of Water Resources, Ministry of Settlement and Regional Infrastructures; 2002-2003 Executive Secretary to the Research and Development Agency, Ministry of Settlement and Regional Infrastructures; From September 2003 till present, as a Senior HRD Instructor, Ministry of Settlement and Regional Infrastructures; From 2001 till present as The Vice President of The Indonesian National Committee of Irrigation and Drainage (INACID).

- He holds three Presidential Awards: (1) The 30 years outstanding services to the Government of Indonesia, August 1996; (2) Presidential Award for an outstanding professional achievement, December 1996; and (3) Presidential Award for special attribute and contribution to the Development Program of Indonesia.

- Mr. Gany has published more than 50 professional papers, beside his experiences to attend national and international seminars, conferences and congresses.
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Figure 1. General location map of 90 River Territories in Indonesia

Figure 2. General Location Map of JABOTABEK on Java Island's River Territory
Figure 4. Surface Water demand and Supply pattern of JABOTABEK Area
Figure 5. General Feature of Water Balance Scenario (Based on Conjunctive Use Alternative) After: Scenario C of JWRMS, 1994.