Bantayan Island Wilderness Area (BIWA)
General Management Planning Strategy

Department of Environment and Natural Resources
Region-7, Central Visayas

August, 2015

Figure 14: Dumped Solid Waste in Barangay Balidbid, Sta. Fe

Dumping of wastes on water bodies causes the spread of toxic chemicals found in plastics and other waste materials to the marine environment killing the diverse aquatic resources including mangrove species. Degradation of organic wastes in water competes for the oxygen demand depriving other organisms from utilizing dissolved oxygen.

Ineffective implementation of the 20m easement zone is also a weakness to the management of BIWA's coastal resources. This is also due to the unavailability of land where the settlers would be transferred.

Cutting and unsustainable utilization of mangrove resources is also a major threat to the integrity of the ecosystem in Bantayan. Based on random interviews, residents living within mangrove swamps utilize the mangrove barks for tannin extraction used in coconut wine making. In effect, mangrove trees die gradually within a span of time after its dermis is exposed to the open air and sunlight. People can't also do away from utilizing mangrove trees as firewood.

Local residents also utilize the mangroves as forage for their livestock (cow, goats, etc.). They often cut the species: *Pagatpat* (*Sonneratia alba*), stunting the growth of the mangrove. The Local Government should impose total ban on mangrove cutting and should instead offer alternative source of food for the resident's livestock.

intrusion along the nearshore when drawdown occurs due to high permeability, secondly, there is a high risk of bacterial and chemical contamination of wells especially in the urban areas. These two problems becomes apparent during the water resources investigation and is discussed later.

2.2 Climatic condition

Based on Thornthwaite's moisture index, the climatic condition of Bantayan Island is classified as dry sub-humid. The average annual precipitation amounts to 1580 mm. There are two pronounced season observed in the area; i.e. dry and rainy season. The rainy season last for about 8 months which runs from May to December.

3 Water resources assessment

Evaluation of the water resources status of the island, both for water quality and volume of groundwater reserve, can be done using a systematic well survey. Well survey was conducted to determine the actual water consumption, the location of groundwater level, and the status of water quality. In addition, observation of hydrologic data such as rainfall and evaporation was undertaken. Details of the survey are presented in the succeeding section.

3.1 Well survey

Well survey was conducted in two separate occasions to determine the groundwater extraction, location of the groundwater table and water quality. The first was conducted in 1988-89, and the second survey was done in 1995. Since the location of the groundwater table fluctuates with hydrologic parameters such as rainfall, the survey was undertaken on the same season. The time of observation during the year as well as pertinent hydrologic data was obtained in order to correlate any variation of the measured data.

3.1.1 Water level

Control wells were selected at random forming a grid in the area of interest. The location of groundwater table was then measured with respect to the mean sea level(msl). The actual groundwater level of control wells were calculated accounting for the influence of tidal fluctuation.

Figure 1 and 2 show the isoline of the groundwater table above the mean sea level obtained in 1989 and 1995, respectively. In the 1995 survey, it is observed that the isoline moved toward the inland which indicate the lowering of the groundwater table and reduction of the freshwater lens. It was observed that a maximum decrease of 1.29 m located at Tangkong area. The decrease of the water level generally observed near the shoreline resulted in the seawater intrusion. This is discussed at length in the next section.

3.3.3 Water demand

The rate of groundwater withdrawal is an important parameter to assess the water availability in the area. For this reason, a survey was conducted to determine the actual groundwater extraction in the area. Result of the survey indicates that the total fresh water demand (extraction within the fresh water lens) is 1.25 M m^3/year.

3.3.4 Groundwater balance

Following the systems concept, a simple groundwater balance can be made. Mathematically, this is expressed as

$$APR = WD + Q + LN + DEF \qquad (3)$$

where WD is the water demand of the community which include domestic and agricultural consumption, Q is the outflow to the sea, LN is the unaccounted losses, and DEF is the observed groundwater deficit. Hence, using the estimated values for each component, the natural losses are calculated as 10.29 M m^3 per year. The natural losses are probably caused by the karst characteristics of the limestone formation as well as the underground cave system.

It can be seen that the annual potential recharge are much bigger compared to the fresh water demand which is 1.25 M m^3/year. However, due to geologic formation, the apparent surplus of water is consumed into natural losses which results into depletion of groundwater reserved.

4 Hydrogeologic problem

As seen in the water balance analysis, there is high annual potential recharge. On the contrary, water level data as well as the conductivity records showed that there is depletion of the groundwater resources. This leads to several theory, one is that the aquifer cannot store water, i.e. water flows directly to the ocean through solution channels, and secondly, the water did not reach the groundwater table and it is lost through evapotranspiration.

The first hypothesis is preferred due to the geology of the area which is karstic limestone. This layer is located at a short distance or depth from the top soil. The presence of the karstic limestone has pros and cons in relation to recharging the aquifer. The advantage is obvious in that the formation is highly porous and has high permeability and/or infiltration capacity. However, because of its inherent property which dissolves in transient water, it may result to solution channels. Thus, water is transported easily to the ocean through solution channels without it being stored in the water bearing formation.

3.1.2 Salinity intrusion

During the well survey, electrical conductivity of the water samples was measured. Conductivity is one of the indicators of water quality in relation to the chloride content of water. Although chloride is present in all natural waters at a concentration up to about 40 mg/L, high concentration of chloride in wells will indicate intrusion of saltwater from the sea; the sea having chloride content of about 19000 mg/L. This is true if there is no other source of chloride which can be traced in the area.

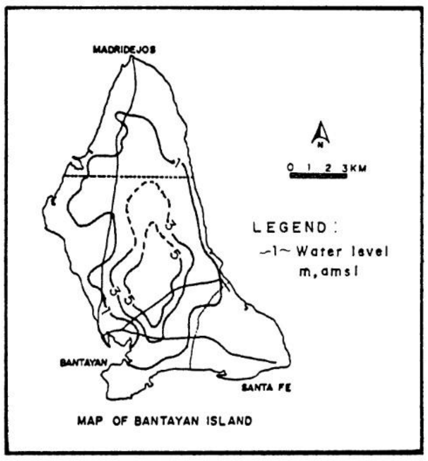

Figure1: Groundwater isoline, 1989

Figure 2: Groundwater isoline, 1995

Water conductivity of control wells was measured directly in the field. Results for the 1989 and the 1995 survey are presented in terms of the iso-conductivity line shown in Figure 3 and 4.

Based on WHO standard for drinking water, the chloride content of fresh water used for drinking must not be greater than 200 mg/L, or approximately equivalent to a calibrated conductivity value of 1350 μS/cm.

It was observed also that saltwater has intruded inland in many areas of the Island especially in highly populated areas. Wells along the shoreline registered conductivity values of more than 1500 μS/cm which is over 250 mg/L or more. Based on the 1989 and the 1995 survey, a progression of seawater intrusion in some of the areas was observed. In Madridejos, the 1500 μS/cm isoline also moved 1 km inland. In areas where the water level elevation is constricted, a high conductivity was observed. This is probably due to the karstic characteristic of limestone formation and the effect of cave system.

Saltwater intrusion was attributed to increase in groundwater extraction due to increasing number of wells in the area. These are the areas with high number of clustered wells. This is aggravated by the type of geologic formation in the area which is limestone.

Transactions on Ecology and the Environment vol 12, © 1996 WIT Press, www.witpress.com, ISSN 1743-3541

Bantayan Island water resources study

P.M. Angus Jr, D.T. Jaque
Water Resources Center, University of San Carlos, Cebu City, Philippines

Abstract

The increasing pressure for development in Bantayan Island led into the study of the water resources status. Two parameters were considered vital in the study, these are the quantity of useful groundwater reserve and the water quality.

Well surveys were conducted in two separate occasions to determine the groundwater level. The first survey was done in 1988-1989, and the second survey was conducted in 1995. In the second survey, assessment of the groundwater quality was also undertaken.

Results of the study showed that despite sufficient annual potential recharge in the island there is still an observable decrease in the groundwater table. Salinity concentration increases on water sources near the coasts which indicates movement of saline wedge towards the inland. Wells near the coasts have recorded chloride concentration of 250 ppm and above. This value exceeded the maximum limit set by the World Health Standard for drinking water.

It was recommended that monitoring of groundwater level and quality of water be conducted. A design of water recovery system will be made to optimise the withdrawal of water without any detrimental impact to the groundwater reserve.

1 Introduction

Development of small islands must be done with great care to achieve a balance and sustainable use of the basic resources such as water. With a limited land area, development of water resources for domestic and agro-industrial consumption requires judicious land use planning and regulation of groundwater extraction.

5 Conclusion

The study was conducted to investigate the water resources status of Bantayan Island. Two main components of the study were considered vital; these are the assessment of the quantity and quality of groundwater. Results from the investigation indicate that groundwater level decreases despite sufficient annual potential recharge. This is mainly due to the geologic formation of the area, which is karstic limestone formation. Solution channels are present in the area which discharged groundwater directly into the sea.

Salinity intrusion is significant especially in the suburbs. Several wells are bacteriologically contaminated by wastes from human and from poultry farms. Result indicates that most shallow wells are contaminated, and hence, they are not suitable for drinking.

6 Recommendations

Results on the water resources status investigation of the island leads to the following recommendations:

1. In critical areas, characterized by a progressive seawater intrusion, regulation of groundwater extraction is essential to prevent further movement of the seawater inland.

2. An alternative source of water supply must be introduced in the affected areas nearshore. This implies that a water system will be designed with its water source located at the fresh water lens.

3. Open dug wells must be rehabilated to prevent from possible entry of contaminants.

4. Considering the extent of bacterial contamination of the water sources in the island it is important that a water laboratory be set-up in conjunction with the sanitation program and water treatment scheme in the island.

5. It is essential that a water recovery system be designed. This system enables collection of water efficiently before it flows to the seawater zone.

References

1. Bouwer, H. *Groundwater Hydrology*, McGraw Hill, 1978.1.

2. Metcalf and Eddy, Inc., *Wastewater Engineering. Treatment, Disposal and Reuse*. 3rd ed., McGraw Hill, 1991.