—MANILA—

The City of Manila

Manila experienced colonial eras under Spain, the United States, etc. but in 1946 it gained independence and due to the influx of population resulting from urbanization and the high birth rate the population is continuing to increase at a rapid speed even now. Since 1975 Metro Manila including Manila City has been in existence as a single independent administrative district, and it functions as the capital of the Philippines. Its population was a mere 200,000 people in 1900 but by 2005 it had become a major city of 10,760,000 people. It is a region facing a variety of problems including slum towns, the wealth disparity problem, etc., but the city is host to the headquarters of the ADB (Asian Development Bank), and development is proceeding.

Impact of flood and land subsidence and resettlement options in Metro Manila

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Figure 1. Flooded street in Malabon during high tide

Figure 2. An abandoned house after heavy flooding

The excessive abstraction of Metro Manila's groundwater over the past decades has caused land subsidence. Thus, there is a need to strengthen the monitoring of groundwater use and groundwater levels, and for the strict enforcement of licensing, permits, and control systems. In addition, an alternative water supply should be provided.

Researchers have shown that the worsening floods of recent years are caused by land subsidence (Liongson et al., 2000; Siringan and Rodolfo, 2003; Rodolfo and Siringan, 2006). In northern Metro Manila, particularly the cities of Kalookan, Malabon, Navotas, and Valenzuela (known as the Kamanava area), the area of land prone to flooding has increased, with floods being longer in duration. Increases in the frequency of low-level floods caused solely by high tides have also been noted (Figure 1).

Surveys were conducted in 2008 and 2009, to assess the socio-economic impacts of floods, to measure flood damage costs and the impact on annual household expenses due to flood events. These surveys revealed that floods, caused by a combination of heavy rains and high tides, in the Kamanava area can cause greater damage than floods solely from heavy rain. The surveys also showed that regular flooding events placed an additional burden on households because of added expenses regarding health, transportation, and damage to houses and household appliances.

Over time respondents had introduced measures to prevent further flood damage and to help cope with recurring flood events such as, the use of landfill to elevate their lots, building a second story or adding an another floor to their houses, and the use of water barriers such as sandbags, wooden planks, or concrete blocks. Some respondents have abandoned their homes (Figure 2) and others who cannot afford any improvements to their lot have taken no action.

Figure 3. Basic utility model (resettlement preferences)

Stated preference discrete choice method (SPDCM)

Basic utility model:

*U(1)=asc1+bamorti1*amorti+bgrant1*grant+bloan1*loan+bdtem*dtem +bdper*dper*

*U(2)=asc2+bamorti1*amorti+bgrant1*grant+bloan1*loan+bdtem*dtem+bdper *dper*

*U(3)=bamorti1*amorti+bgrant1*grant+bloan1*loan+bdtem*dtem+bdper*dper*

Table 1. Results of stated preference discrete choice experiment

Alternative/ attribute level	Parameter coefficient	Standard error	*t-value*	*p*
Alternative specific constant				
Resettlement 1 (20kms away)	-0.687	0.4091	-1.68	0.0931*
Resettlement 1 (40kms away)	-3.313	0.5587	-5.930	<0.01***
AMORTIZATION	-0.0053	0.0005	-10.222	<0.01***
GRANT	.50345D-05	.1318D-05	3.795	<0.01***
LOAN	.136822D-04	.3326D-05	4.115	<0.01***
BDTem	-.66935	0.2803	-2.388	0.0170**
BDPer	1.2042	.2647	4.549	<0.01***

***denotes significance at 1% level, **at 5% level and * at 10% level

Long-term groundwater policy measures are needed to reduce subsidence rates. However, regular flooding is a continuous threat in Kamanava, which needs to be addressed immediately. One of the options being considered is voluntary resettlement of flood-affected households. However, before any policy intervention, it is necessary to assess the preference of residents to resettle to a flood-free area and to see trade-offs if economic incentives are given. A stated preference discrete choice method (experiment) was conducted to assess the probability of households to accept resettlement plans with economic incentives, such as low amortization rates, grant, loan and employment (Figure 3).

The results of the choice experiment reveal a negative propensity to resettle to another location either 20 or 40 kilometers away from Kamanava. But the economic incentives such are highly significant with the expected signs. Among the economic attributes, the provision of permanent job is the most important factor that will encourage residents to resettle.

It is therefore necessary to improve resettlement programs which secure employment of residents and provide adequate social services.

Liongson LQ, Tabios III GQ and Castro PM, editors. Pressures of Urbanization: Flood Control and Drainage in Metro Manila. University of the Philippines-Center for Integrative and Development Studies, 2000. **Siringan FP and Rodolfo KS**. Relative sea level changes and worsening floods in the western Pampanga Delta: Causes and some possible mitigation measures. Science Diliman 2003; 15: 1-12. **Rodolfo, KS and Siringan, F.** Global sea-level rise is recognized, but flooding from anthropogenic land subsidence is ignored around northern Manila Bay, Philippines. Disasters 2006; 30(1):118-139.

Groundwater in Manila

The distinctive feature of the groundwater situation in Manila is that the city has a hard geological layer so a fall in the groundwater level can be seen but not much land subsidence can be seen. Furthermore, the city constructed a dam as a measure to conserve groundwater and has endeavored to ensure there are sufficient water sources and as a result there are also regions in which the groundwater level has recovered. Nonetheless, the state of the foundation is extremely uneven across the region, so land subsidence is becoming serious in the soft foundation in the areas around the coast. In these kinds of places there are even some regions in which the damage is so serious that seawater inundates the region every day at high tide, so measures designed to take into account regional characteristics are thought to be necessary.

Groundwater Pollution in Manila

In several locations, the high concentration of “nitrate-nitrogen” caused by the load of household waste water and industrial waste is detected, but measures to address the problem are lagging. Furthermore, in addition to the rapid progress of urbanization, an enormous garbage dump is constructed in the Marikina River basin, and the pollution problem caused by this is concerned.

The history of eutrophication recorded in a sediment core

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Figure 1. Osaka

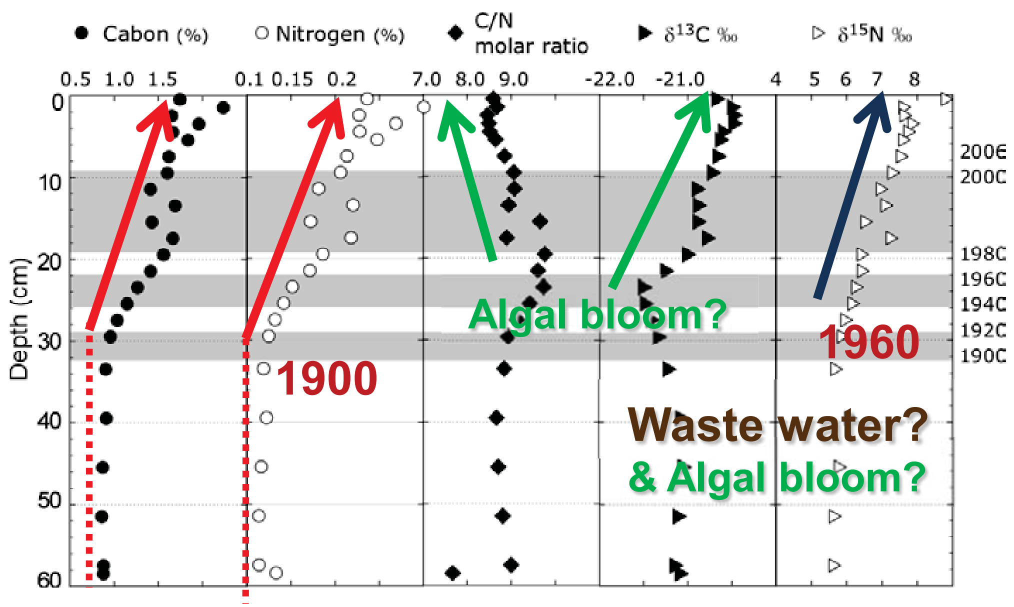
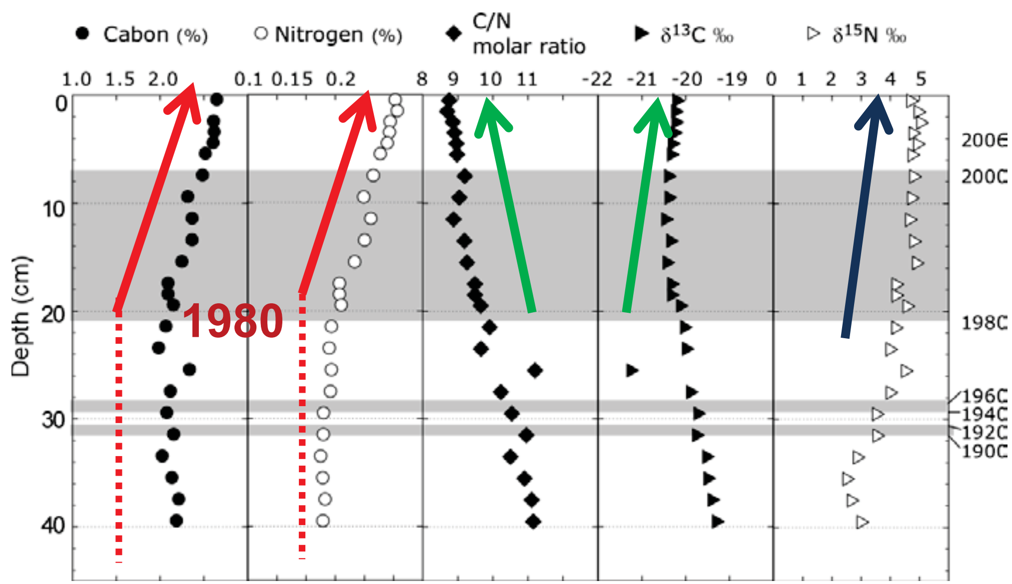


Figure 2. Manila



Carbon (C) and nitrogen (N) contents have continuously increased since 1900 in Osaka and since 1980 in Manila. On the other hand, the trends of the C/N ratio and δ^{13}C changed drastically around 1960 in Osaka, suggesting an algal bloom due to nitrification. Similarly, there was an increase in δ^{15}N probably due to the combination of a wastewater contribution as a nitrogen source and the effects of isotopic fractionation related to phytoplankton bloom under a hypereutrophic condition.

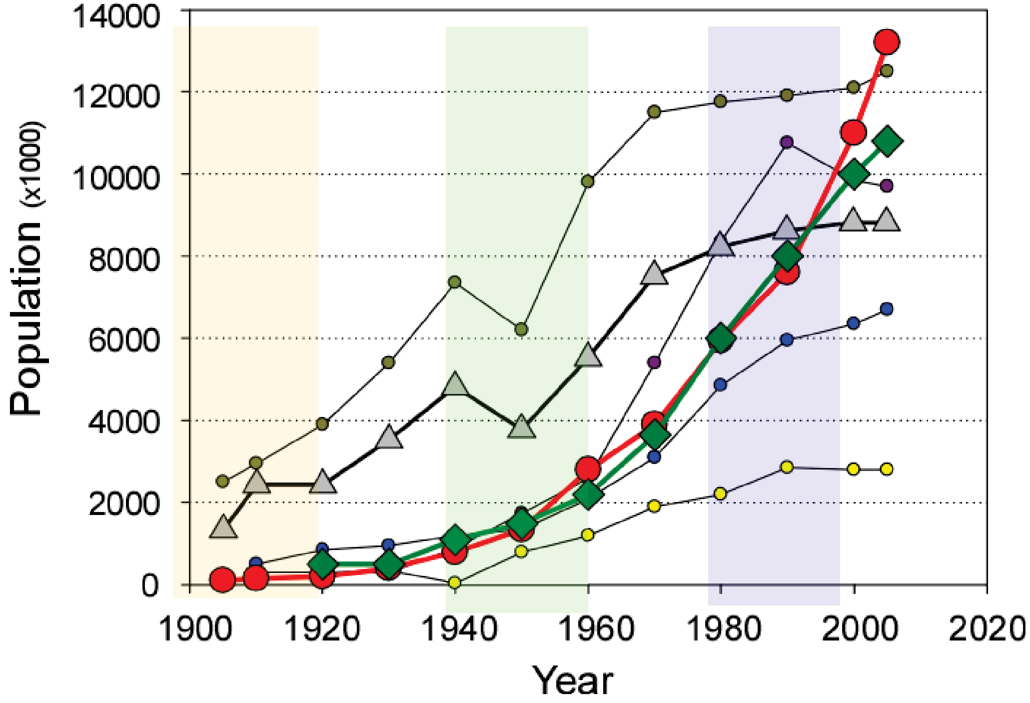
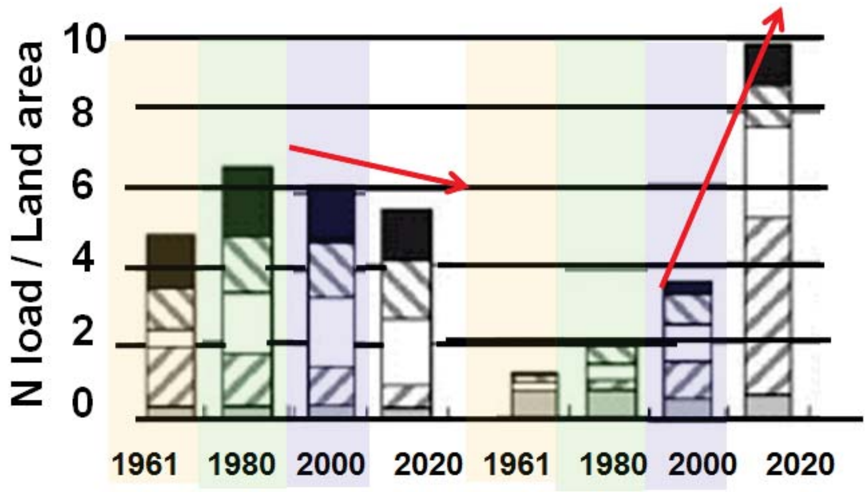


Figure 3
Time series of the population in Osaka, Manila and other cities



Shindo et al. (2006) Ecol Model

Figure 4. Estimated N loads with rapid economic growth in Osaka and Manila from 1961 to 2020

There has been an increase in population since 1900 in Osaka and since 1960 or 1980 in Manila and other mega-cities in South East Asia (Fig. 3). The population increases are reflected by N loadings. However, at a mature stage of urbanization, the loadings can be attenuated by advanced sewage treatment plant and dust removal systems (Fig. 4). The shift in N loadings corresponds with the trends of C and N profiles in the sediment core (Figs. 1 and 2).

Umezawa et al. “Carbon and Nitrogen Characteristics of Sedimentary Organic Matter as Indicators of Historical Trophic State in Osaka Bay, Jakarta Bay, and Manila Bay “ AOGS, Buasn, 2008.