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Major impacts of sea-level rise on agriculture in the Yangtze delta area around Shanghai

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Abstract

The projected rise in sea level for the next century will have profound impacts on peri-urban agricultural production in the Yangtze delta area. This paper assesses the major impacts of the rise in sea level on coastal processes, flood hazards and saline water incursion in relation to sustainable development of peri-urban agriculture in the deltaic plain around Shanghai, People's Republic of China. It is concluded that the rise in sea level will cause coastal erosion along the southern coast and slow sedimentary accretion in a number of shoals within the Yangtze estuary. This change will severely limit the extent of intertidal flats available for land reclamation. The rise in sea level will also increase flood risk, raise the groundwater table and prolong waterlogging. Consequently, agricultural yields will be seriously reduced. During dry seasons, saline water will dominate the deltaic area for much longer periods and shortages of freshwater for agriculture are expected to be more pronounced. Four counter-measures have been adopted by the Shanghai Municipal Government in an attempt to mitigate the effects of sea-level rise. © 1999 Elsevier Science Ltd. All rights reserved.

Keywords: Agricultural production; Groundwater table; Floods; Peri-urban agriculture; Saline intrusion; Sea-level rise; Shanghai; Yangtze delta

Introduction

Global warming is causing sea level to rise. Along the east coast of China, mean sea level has risen at a rate of 1.0 mm y^{-1} from 1920 to 1987, with the mean level

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of high spring tides elevated at 2.5 mm y^{-1} (Chen, 1991). During the last 30 years, it has also become evident that high tide floods within the Huangpu River in Shanghai have become more frequent and reached higher altitudes. The rise in sea level is expected to accelerate during the next century at a rate as high as 9–10 mm y^{-1} which, on a global scale, is probably unprecedented over the last several thousand years (IPCC, 1995). This rise in sea level is expected to have significant impacts on economic development in low-lying coastal areas around the world. In the Yangtze delta area, it is very likely that sea level will have risen by 50–70 cm by the year 2050 (Chinese Academy of Sciences, 1994). In an assessment of the general impacts of sea-level rise on the Shanghai area, Wang et al. (1995) raised a number of issues to which coastal engineers and planners must pay attention.

Rapid industrial and urban development during the last few years has reduced arable land for peri-urban agriculture around Shanghai. Further development early in the next century will inevitably convert more agricultural land into urban land uses. Sustaining the production of peri-urban agriculture in the Yangtze delta area to support Shanghai's urban expansion and economic development has been one of the key issues facing the government. In 1997 the Organization for Shanghai Sustainable Development identified an urgent need for scientific research to address specific problems related to strategic development plans such as China's Agenda for the 21st Century in the Shanghai Action Plan.

This paper therefore presents results from one of the projects recently undertaken through a special research programme led by the Shanghai Municipal Government. The paper is confined to two aspects: the impacts of a 0.5 m sea-level rise by the year 2050 on peri-urban agricultural production; and the land availability for reclamation in the Yangtze delta area around Shanghai. Discussion focuses on issues of tidal flat accretion, groundwater table movement, flood hazard and saline water intrusion in relation to the projected sea-level rise. Effects of some major engineering projects in the Yangtze catchment area and the urban expansion programme in Shanghai are considered, whilst the responses of the Shanghai Municipal Government towards rising sea level are commented upon.

Geographical background

The Yangtze delta covers an area of 51 800 km^2. Its natural environment, being favourable for agriculture, has attracted people for several thousand years (Chen & Stanley, 1996). Due to its strategic location and closeness to waterways (Fig. 1) at the centre of the deltaic plain, Shanghai became a local administrative centre as early as the South Song Dynasty around AD 1265 (Chu, 1996). Since then, economic activity has increased rapidly; by the 20th century, Shanghai had become the largest urban, commercial and industrial centre in China. However, it cannot enjoy its prosperity without the support of peri-urban agriculture in the deltaic area.

Administratively, Shanghai includes the metropolitan area and 10 counties (Fig. 2). In 1949 there were 372 100 ha of agricultural land. During the period 1949–1975, the total amount of land reclaimed from intertidal flats was almost equal to the

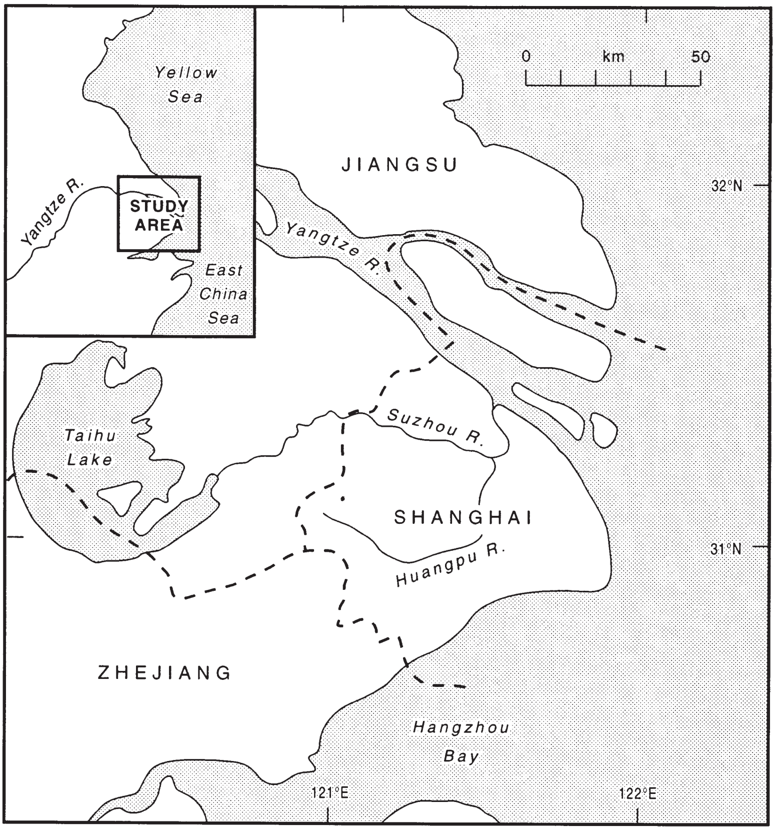

Fig. 1. Location of the study area on the east coast of China. Water from Taihu Lake is also drained through numerous smaller channels into the Huangpu River.

amount of land being converted into urban and industrial uses (Tables 1 and 2). Since 1976, the speed of land reclamation has decreased sharply, whilst loss of agricultural land for industrial development has accelerated. As a result, there had been a net loss of agricultural land of as much as 79 100 ha by 1995. This trend is expected to continue into the next century as urban and industrial developments take place in the Pudong area and the county towns of Shanghai.

In order to build a prosperous and modernized metropolis in the Far East, Shanghai has planned to expand its metropolitan area eastward, across the Huangpu River into the Pudong area between the Huangpu and Yangtze rivers (Fig. 3). Effectively, much of Chuansha county that falls into the Pudong area will be merged into the Shanghai metropolitan centre. At the same time, all county towns and townships are expanding for industrial development and residential housing. The Organization for Shanghai Sustainable Development has envisaged that this urbanization project will inevitably occupy much more peri-urban land that has been under cultivation. In fact, in the Pudong area alone, of the 5302 ha used for vegetable production, 2580 ha were con-

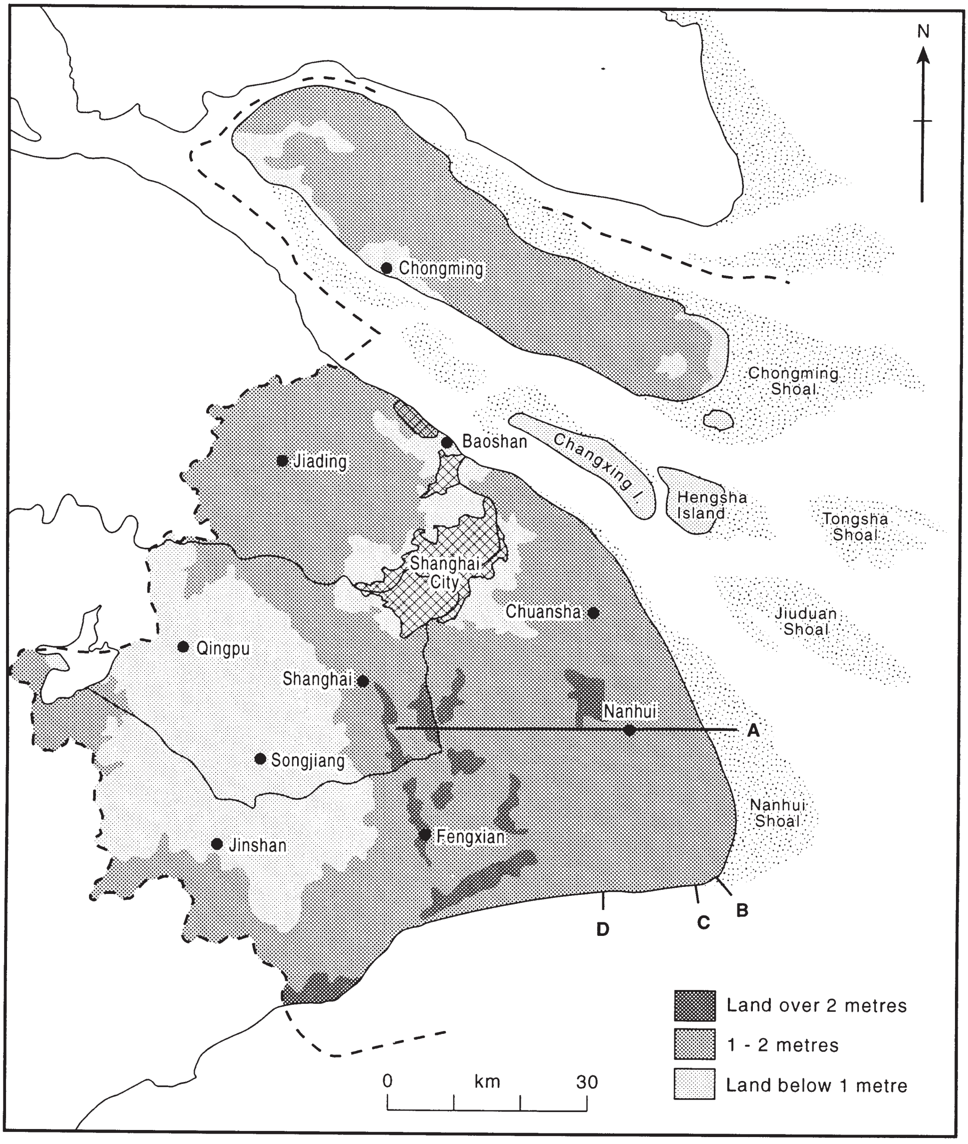

Fig. 2. The location of Shanghai City, its county towns and important shoals. Land above mean sea level is shaded and the depressions in which the city centre and the three western counties are located are clearly shown. Details of the four transects (A: Nanhui; B: Nanhui Point; C: Luchaogang; D: Zhonggang) are presented in Fig. 4 and Table 4.

Table 1
Land reclamation and conversion of agricultural land to urban and industrial land use over the past 45 years in the Shanghai area

Year	Area reclaimed (ha)	Reclamation rate (ha y^{-1})	Converted to urban and industrial use (ha)	Conversion rate (ha y^{-1})
1949–1975	57 400	2296	57 000	2280
1976–1985	7680	768	40 000	4000
1986–1995	7220	722	54 400	5440
Total	72 300	–	151 400	–

verted into urban land uses during the period 1988–1993 (Mei & Zhu, 1996). As a result, vegetable supplies to Shanghai have been severely affected. In the context of sea-level rise in the next century, it is therefore necessary to investigate whether there will be sufficient intertidal flats for land reclamation and what will happen to the existing agricultural land and that still to be reclaimed.

Methods and data sources

This study adopts an overarching approach allowing several lines of evidence to be appraised comprehensively and various sea-level-related issues to be discussed. These analyses are followed by a discussion of some institutional aspects and the policies related to hazard mitigation in the local context. Sedimentary and archaeological evidence was gathered on shoreline movements in relation to sea-level changes over the past 7000 years. Details of shoreline movement over the past 400 years were obtained from government archives which recorded land reclamation, sea defence construction and the development of drainage systems within the deltaic plain. Aerial photographs and bathymetric data were used to calculate shoreline movements and shoal development over the last two decades. The analysis of agricultural production was based on agricultural census reports and altitudinal data. Finally, tide-gauge records were used to assess the impacts of the 0.5 m rise in sea level by the year 2050.

Table 2
A summary of land reclamation and land-use change in the Shanghai area, 1949–1995

Agricultural land in 1949 (ha)	Reclaimed 1949–1995 (ha)	Converted to urban and industrial use, 1949–1995 (ha)	Agricultural land 1995 (ha)	Net loss of agricultural land 1949–1995 (ha)
372 100	72 300	151 400	293 000	79 100

Impacts of sea-level rise

Intertidal land resources

Sedimentary and archaeological evidence reveals that relative sea level has changed little over the last 7000 years, fluctuations being less than 1 m (Chen et al., 1989). The period 7000–2000 BP saw rapid sedimentation within the middle and lower reaches of the Yangtze, resulting in little sediment being transported into the deltaic area (Chen, 1996). During the same period, a series of chenier-type ridges was developed along the landward margin of the deltaic plain (Chen et al., 1989). As the river channel adjustment came to an end around 2000 years ago, the Yangtze deltaic shoreline began to advance (Fig. 4).

Yang and Lu (1992) indicated that along the east coast of China sea level was relatively stable from AD 100 to 1100, while from 1100 to 1600 there was a rise of only 0.5 m. The period of stable sea level clearly coincided with rapid shoreline advancement in the southern part of the delta (Fig. 4) and the growth of a number of shoals in the northern part (Chen et al., 1989). A small rise in relative sea level from 1100 to 1600 was related to the northward shift of the principal channel of the Yangtze Estuary (Chen & Zong, 1998). Consequently, this period saw a slow advancement in the southern shoreline and coastline instability of such reclaimed shoals as Chongming Island, where the county town was forced to move away from

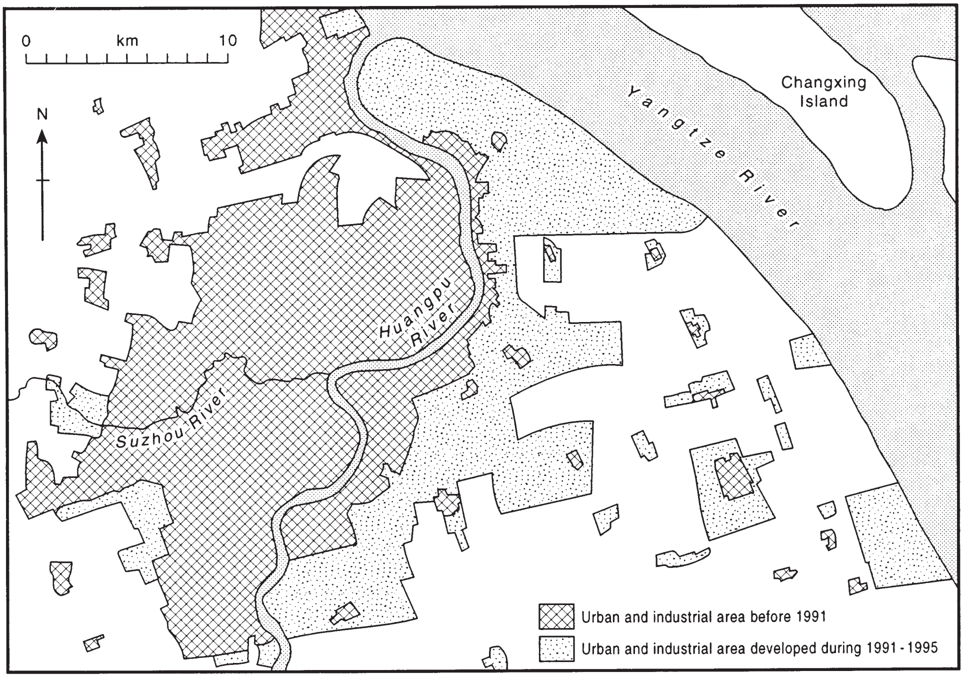

Fig. 3. Newly expanded urban and industrial areas in the Pudong area.

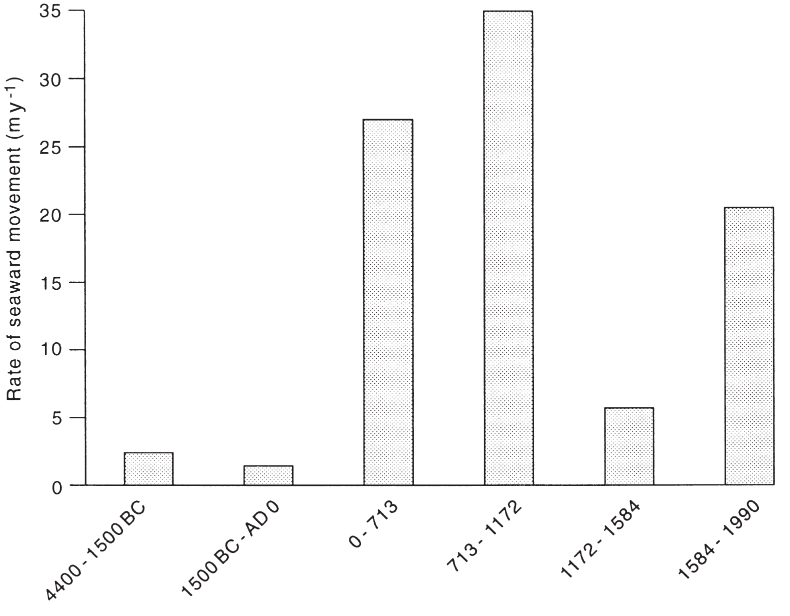

Fig. 4. Rates of seaward movement of the Yangtze deltaic shoreline from 4400 BC to the present day.

the coast five times (Chu, 1996). From 1600 to 1900, a small fall of 0.3 m was suggested by Yang and Lu (1992). This period saw a rapid advancement in the southern coast and the merging of shoals into the northern shore (Chen & Zong, 1998; Chen et al., 1989).

During the 19th century, the average rise in relative sea level was 1 mm y^{-1} (Chen, 1991). Since 1970, relative sea level seems to have risen faster (Ma et al., 1996). Human activities have intensified in the deltaic area over the past five decades. The east shoreline of the Chongming Island has advanced 15.2 km since 1955 (Table 3), although the altitude of the most recently reclaimed land at the east end of the island is relatively low (see Fig. 2). Due to human factors, the impacts of the recent sea-level rise are not clear in the case of Chongming island.

Along the coast adjacent to Hangzhou Bay a recent survey at three locations between Nanhui Point and Zhonggang (Fig. 2) shows the shoreline has been unstable

Table 3
Eastward expansion of Chongming Island based on reclamation records

	825–1762	1762–1755	1955–1964	1964–1976	1976–1985	1985–1992
Expansion (m)	6500	4700	5300	2400	2500	5000
Rate (m y^{-1})	6.9	24	588	196	278	714

Table 4
Shoreline movements along the south coast of the Yangtze delta based on three surveys measuring distance (m) from shoreline to 0 m contour[a]

Year	Zhonggang	Luchaogang	Nanhui Point
1983	600	110	700
1987	0	130	1200
1991	40	100	600

[a]Transect location shown in Fig. 2.

during the period 1983–1991 (Table 4), when relative sea level rose faster (Wang et al., 1995). The 0 m contour at Nanhui Point moved 500 m seaward from 1983 to 1987, retreating 600 m during 1987–1991. By contrast, the shoreline at Zhonggang retreated 600 m and then advanced by 40 m (Table 4). Furthermore, during the period of relatively stable sea level before 1970, there was a rapid vertical growth in both Jiuduan Shoal and Tongsha Shoal (Fig. 2). Since 1970, the growth of the two shoals has slowed or become stagnant (Table 5).

One may possibly argue that, although the Yangtze deltaic shoreline has been sensitive to sea-level change, other factors, such as sediment supply, may be equally important to shoreline movement. It is true that during the last 50 years there has been widespread cultivation within the Yangtze catchment area, causing severe soil erosion and increasing sediment supply (Lu & Higgitt, 1998). However, most of the eroded soil has been trapped by newly constructed reservoirs and there has been no net increase in sediment discharge from the upper catchment of the Yangtze (Higgitt & Lu, 1996).

Chen and Zong (1998) have indicated that during the coming decades sediment supply from the catchment area to the deltaic plain is likely to be reduced due to the Three-Gorge Dam, which is expected to trap up to 60% of the total annual sediment output of the Yangtze catchment. Future sea-level rise, therefore, in combination with the effects of this engineering project, will inevitably destabilize the deltaic shoreline and may even cause it retreat. Although at present it is difficult to quantify the impacts, it is certain that there will be far fewer intertidal shoals avail-

Table 5
Vertical accretion of Jiuduan Shoal and Tongsha Shoal since 1880

Survey period	Jiuduan Shoal		Tongsha Shoal	
	Vertical growth (cm)	Average (cm y^{-1})	Vertical growth (cm)	Average (cm y^{-1})
1880–1920	0	0	1400	35.0
1921–1973	3900	73.6	1800	34.0
1974–1979	90	15.0	−40	−6.7
1980–1990	−80	−7.3	10	0.9

able for land reclamation. Within the next decade, it may still be possible to reclaim some land from the Chongming Shoal, Jiuduan Shoal and Nanhui Shoal (see Fig. 2). After the next decade, when the engineering project is completed and starts to function, most of the shoreline within the deltaic area is likely to be under threat of erosion.

Agricultural production

Areas immediately adjacent to metropolitan Shanghai have experienced severe land subsidence due to groundwater extraction for industrial development between 1956 and 1966 (Chen, 1991). Since then, there has been less groundwater extraction and ground subsidence has been reduced to <10 mm y^{-1}. Areas further away from the city centre have been less affected. However, repeated levelling from 1957 to 1987 suggested that the whole deltaic area has been subsiding at a rate of 3 mm y^{-1} due to a combination of crustal movement and compaction of the unconsolidated sediments (Hu et al., 1992). By the year 2050, the land surface of the deltaic plain will be 15 cm lower than at present. Thus, the actual rise in mean sea level (msl) in this area is expected to be 0.65 m, based on the projected global sea-level rise of 0.5 m (IPCC, 1995). The impact of such a rise in sea level on agricultural production in the Yangtze delta area can be discussed in terms of: (1) a rise in the groundwater table; (2) an increase in inundation frequency; and (3) the prolongation of annual saline water intrusion.

In Fengxian, Nanhui, Chuansha, Shanghai, Jiading and Chongming counties, the average depth to the groundwater table is about 1.0–1.2 m. Such depth can be maintained at present because of the appropriate provision of sea defences and drainage systems. However, by the year 2050, the average depth to the groundwater table in these counties will be reduced to 0.35–0.55 m as sea level rises. According to a survey in Qingpu county in 1988–9, wheat production will be significantly reduced if the depth to the groundwater table is less than 0.5 m (Fig. 5). This implies that much of the agricultural land in these six counties will have significantly lower yields by the year 2050, unless the electric pumping capacity is increased and a much larger supply of electric power is guaranteed. Furthermore, much of the agricultural land in the counties of Jinshan, Songjiang, Qingpu and Baoshan, which includes Changxing and Hengsha Islands, will certainly become unproductive. At present, the average depth to the groundwater table in these four counties is already around 0.5 m and agricultural production is heavily reliant on electric pumping in wet seasons.

Sea flooding and waterlogging have been amongst the major natural hazards in the area since 95% of agricultural land within the Shanghai area is below the high astronomical tide (2.4 m above msl) (Fig. 2), which ranges 2.5–1.0 m above msl in Chuangsha county (Fig. 6) and 1.5–0.6 m above msl in Songjiang county (Fig. 7). On Chongming Island, the ground varies between 1.1 and 2.3 m above msl, whilst on the newly reclaimed Changxing and Hengsha islands, the land surface ranges from 0.5 to 0.9 m above msl. This agricultural land suffers waterlogging each year due to the sustained early summer rainfall and typhoon storms in late summer and early autumn. In Songjiang county, for example, water levels at Mishidu can rise

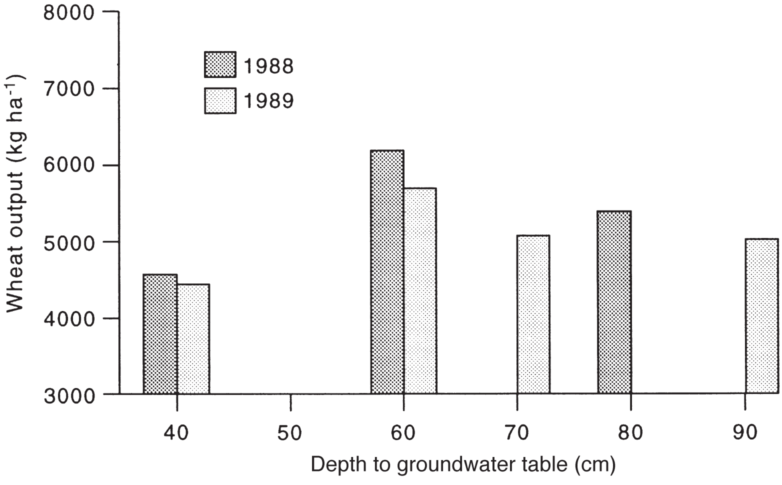

Fig. 5. The relationship between wheat yield and groundwater table based on a survey in Qingpu county, 1988/9.

up to 2 m above msl during normal tidal cycles. This level is already higher than the ground level of the county (Fig. 7). Mishidu, situated 20 km east of the county town of Songjiang, is the main floodgate on the Huangpu River, stopping tidal currents running upstream into the three western counties. By the year 2050, as sea level rises 0.65 m, this floodgate will have to be closed during most of a tidal cycle, leaving little time to drain water from Taihu into the estuary. As suggested in Table

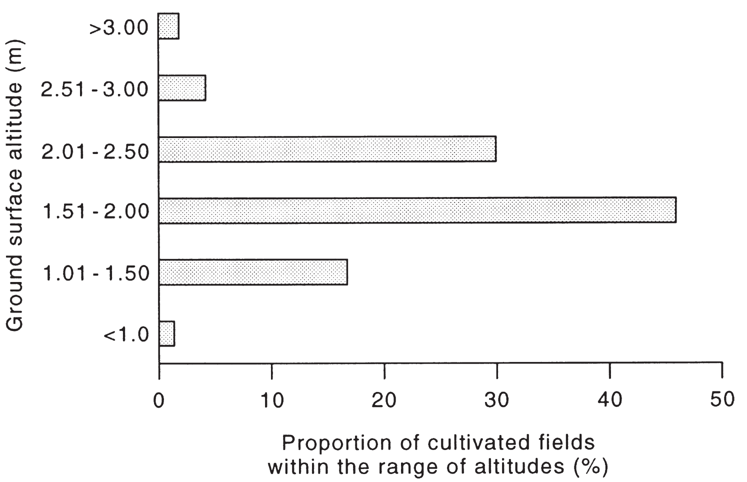

Fig. 6. Altitude (above msl) and cultivation for Chuansha county. Note that the majority of land is below the level of highest astronomical tide of 2.4 m. Agricultural production is dependent on the protection provided by sea defences.

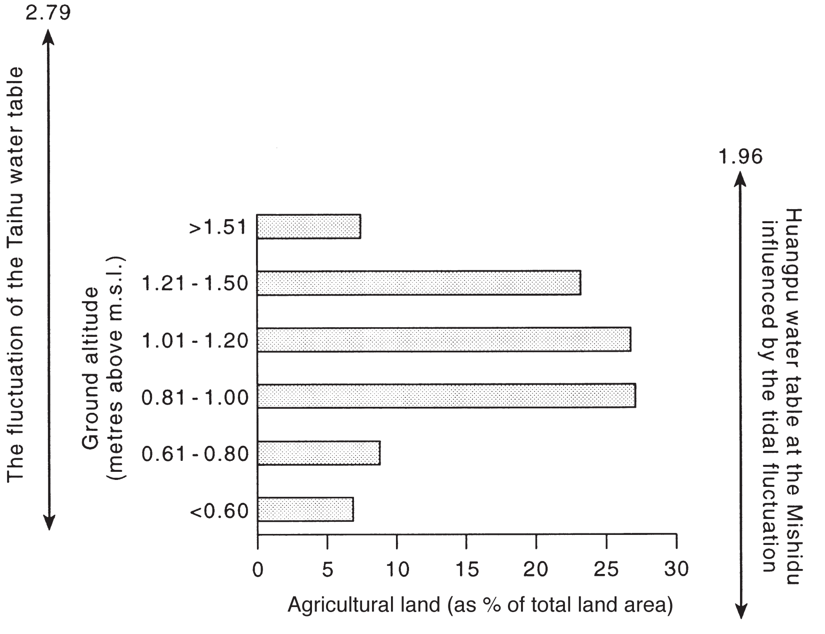

Fig. 7. Altitude of agricultural land in Qingpu county with indication of water tables at Mishidu and Taihu.

6, some of the land in Jinshan, Songjiang, Qingpu and Baoshan counties will become uncultivable during rainy seasons, while heavy engineering pumping systems will have to be established to sustain the agricultural production in Nanhui, Chuansha, Shanghai, Jiading and Chongming counties.

Keeping the groundwater level low has been crucial for lowland agriculture; the local inhabitants have long battled against nature in the Yangtze delta area. As early as the Tang Dynasty (AD 618–907), the local people started to enclose their land

Table 6
Water levels and ground altitudes (m above or below present msl) in selected counties

County	Altitude (m)	At present		By the year 2050	
		Mean high water	Mean low water	Mean high water	Mean low water
Songjiang	0.6–1.8	1.10	−0.10	1.75	0.55
Qingpu	0.6–1.9	1.10	−0.10	1.75	0.55
Chuansha	0.9–2.4	1.65	−0.80	2.30	−0.15
Baoshan[a]	1.2–2.8	1.60	−0.60	2.25	0.05
Chongming	1.0–2.3	1.65	−0.80	2.30	−0.15

[a]Excluding Changxing and Hengsha Islands.

by building dikes with sluices to control drainage and irrigation (such a dike–sluice system is called *Wei* in Chinese). In Qingpu and Songjiang counties, thousands of small *Weis* formed an interdependent network. Recently, electric pumping has been introduced to enhance the drainage capacity of the *Wei* systems across the deltaic area. At the same time, small *Weis* were merged into large ones and the dikes strengthened. These systems were built to keep the floodwater out of the agricultural land during high tides and after heavy rains, and to drain the land during low tides so that the groundwater table can be kept low. However, as sea level rises over the next 50 years (Table 6), it will be impossible to drain more and more *Weis* in Qingpu and Songjiang counties naturally during low tides. At present, electric pumping is needed only during rainy seasons and after a flood. Such an artificial drainage technique is likely to become a daily routine in the coming decades.

During the 19th century, the deltaic plain was flooded 33 times by a combination of abnormal high tides in the estuary and heavy rainfall in the Taihu area. By the year 2050, the frequency of such conditions is likely to increase and the agricultural land will become more vulnerable to sea flooding. The situation may be exacerbated when the city centre is under threat of flooding. In September 1981, when a typhoon struck Shanghai, the water level on the Huangpu River near the city centre reached 3.60 m above msl, the same height as the sea defences. In order to protect the urban area, the government had to divert the floodwater through sluices into the Pudong area and Chuansha county, flooding thousands of hectares of agricultural land.

On average, 79.6% of the freshwater consumed by Shanghai's agricultural production is from the Yangtze River. During wet seasons, the freshwater is pushed upstream through the Huangpu River and other small creeks by high tides. However, during dry seasons, when the freshwater discharge from the Yangtze decreases, saline water extends as far as the west end of Chongming Island. Consequently, the tidal water running into the Huangpu River becomes saline. During the winter of 1978 and the spring of 1979, when freshwater discharge from the Yangtze reduced to 7300–8000 $m^3 s^{-1}$, Chongming Island, with a population of about 750 000, was completely surrounded by saline water for five months. As a result, the rice seedlings could not be transplanted due to the shortage of freshwater and production that year was greatly reduced. At the same time, the maximum water chlorinity reached 1330 ppm around Shanghai City and 488 ppm in the county town of Qingpu.

Freshwater discharge from the Yangtze varies greatly from 84 000 $m^3 s^{-1}$ in August 1954 to 6730 $m^3 s^{-1}$ in September 1963, with a minimum 4600 $m^3 s^{-1}$ recorded on 31 January 1979. In the coming decades, the water transfer project is to take constantly at least 3000 $m^3 s^{-1}$ from the Yangtze to northern China (Chen & Zong, 1998), while there will be a rapid increase in demand for water within the middle and lower catchment of the Yangtze. Coupled with these changes, a rise in sea level is expected to greatly intensify water shortages in the deltaic area, while water quality within the Huangpu and other deltaic rivers is likely to deteriorate, posing a challenge to the sustainability of the peri-urban agriculture in the Shanghai area.

The response of the Shanghai Municipal Government

In order to understand the extent and magnitude of the sea-level rise induced by global warming in a regional and local context, Chinese scientists began their research as early as the 1980s. Since then, several studies on sea-level change and its impacts have been carried out in the Shanghai area (e.g. Chen, 1991; Chen & Chen, 1991, 1994; Wang et al., 1995). By 1994, when some of the findings from investigations organized by the Earth Science Division of the Chinese Academy of Sciences were published (Chinese Academy of Sciences, 1994), the Shanghai Municipal Government began to pay more attention to the issues, funding a two-year research programme on the likely socioeconomic impacts of future sea-level rise and the associated mitigation measures. This research programme involves three government departments and eight research institutions.

In 1997, the results of one of the 13 special projects (as presented in the previous sections of this paper) were reported to the Shanghai Municipal Government. Since then, a series of mitigation measures have been proposed. As far as agriculture is concerned, the following measures are being urgently adopted to mitigate potential hazards induced or intensified by the rising sea level (Fig. 8).

1. *Drainage quality and capacity to be improved.* It is estimated that about 7 000 000 m^3 of sediments accumulate annually in the rural river networks. Such

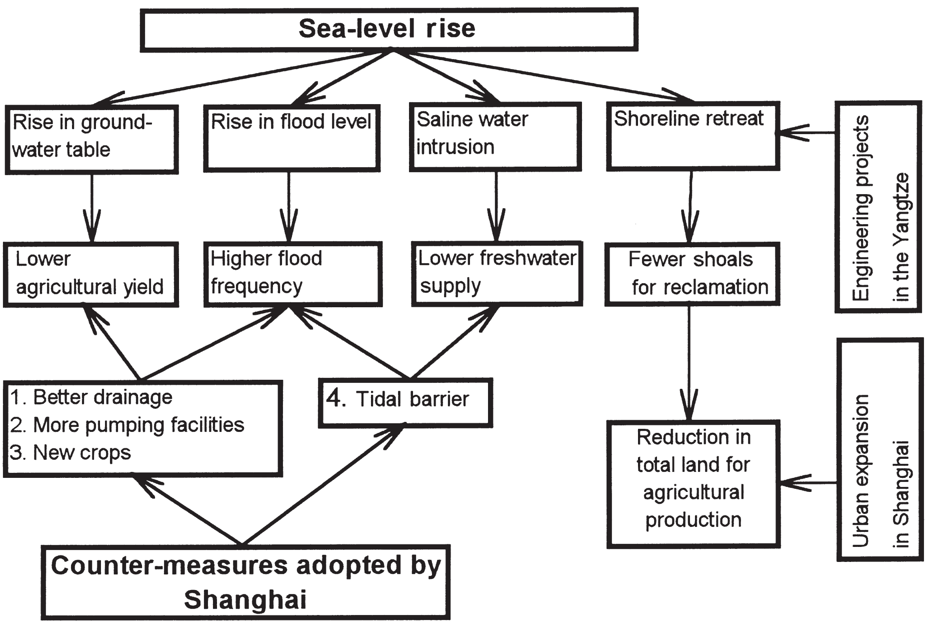

Fig. 8. The major impacts of sea-level rise and the counter-measures adopted by the Shanghai Municipal Government. The effects of engineering projects in the Yangtze catchment and rapid urban expansion in the Shanghai area are also included.

aggradation in river channels helps increase the floodwater table in both tidal and non-tidal rivers. Consequently, the groundwater table rises in the *Wei* systems. Thus, channel dredging of the rivers is considered necessary. However, the effects of dredging may be cancelled out by further joining of *Weis*. Historically, there have been conflicts between different government departments. When the Flood Hazard Prevention Bureau tried to maintain as many channels as possible for drainage, the Agricultural Department wanted to increase production by joining *Weis* together and filling up small channels. There are also conflicts between different regional governments. For example, the Shanghai Municipal Government hopes that the water-storage capacity of Taihu Lake can be maintained to reduce flood risk in the Shanghai area, while the provincial governments of Jiangsu and Zhejiang would like to see further land reclamation taking place in Taihu to increase crop production. All these pressures are related to the huge population of China that needs to be fed.

2. *Pumping facilities to be renewed and increased*. Over the last four decades, 895 pumping stations have been built in the rural part of Shanghai. These stations consume in total about 596 million kW of electric power. However, more than 50% of the pumping facilities are over 20 years old. In order to cope with the likely rise in the water table, considerable investment is needed to increase the capacity of the pumping and irrigation systems. This goal seems achievable since funds for such investment will be available as the government revenue increases at the same rate as the economy grows.
3. *New crops tolerant to higher groundwater table to be developed*. Wheat is one of the major grain crops in the deltaic area. Unlike rice, it is highly vulnerable to variations in the groundwater table. If new types of wheat can be developed, the dependence on electric pumping and crop damage due to waterlogging may be reduced. However, there is no guarantee that the development of new crops will be successful.
4. *The construction of a flood barrier at the mouth of the Huangpu River*. The Huangpu River is strongly influenced by tidal fluctuations. Over recent decades, the tidal level recorded within the Huangpu River has been constantly rising. As a result, sea and river defences along the Huangpu River have had to be raised successively. It is now proposed that a flood barrier be built at the mouth of the Huangpu River to control the water level, rather than having to raise the height of the defences in the near future. A feasibility study is being undertaken, involving not only an engineering assessment, but also integrated planning for the river defence and drainage systems.

To a certain extent, this assessment of major impacts of sea-level rise on agriculture in the Yangtze delta area around Shanghai, together with results from other related projects, has helped to shape planning and hazard-mitigation policies in relation to sea-level rise. The four counter-measures will help to maintain the productivity of the existing agricultural land. Due to population pressure, agricultural production will still be of paramount importance to China in the decades to come. However, urbanization and industrial development in the Shanghai area may be prioritized over agriculture. Eventually, a certain amount of the existing agricultural land will be converted into urban land use. Furthermore, it is unlikely that the availability of tidal shoals for land reclamation will increase, given the effects of the engineering projects in the Yangtze catchment and the lack of desirable measures (Fig. 8). The end result will be a net loss of agricultural land and a decrease in production.

Conclusion

The rising groundwater table and the shortage of land and freshwater in the coming decades seem inevitable due to the projected rise in sea level. These problems are set to become major obstacles to the sustainable development of peri-urban agriculture in the Yangtze deltaic area, which in turn will affect economic and industrial development in the urban area. In an attempt to sustain economic growth in the area, as part of its comprehensive approach to planning, the Shanghai Municipal Government has adopted four counter-measures. Although these aim to maintain the current level of agricultural production, the combination of possible shoreline retreat, rapid urbanization in the Shanghai area and the effects of engineering projects in the Yangtze catchment will result in a net loss of agricultural land and an eventual decrease in agricultural production in the area. Planners in Shanghai appreciate that the impacts of sea-level rise are complicated and that desirable counter-measures are difficult to undertake, particularly when the interests of different administrative regions (provinces) or different government departments are in conflict.

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