Mekong River Commission

Basin Development Plan Programme, Phase 2

Assessment of basin-wide development scenarios

List of Technical Notes

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Note: Technical note on Fisheries Assessment is being prepared. Only power point presentation is available

Part 3: Impacts of salinity intrusion changes

1 Development objective 3: Manage salinity intrusion in the Mekong Delta

1.1 Impact of high salinity on agricultural production

Saline water intrusion in the lower Mekong delta is a problem described by amongst others White (1996), Tuong *et al.* (2003) and Kotera *et al.* (2008). Saline water is known to extend more than 50 km inland during the dry season and close to 2 million ha of land is subject to dry season salinity. Saline water and saline soils are a serious constraint in agriculture: rice yields are negatively effected. In the Delta there are a number of projects and planned projects aiming to restrict the intrusion of salt water (White, 1996 and Tuong *et al.* 2003).

Crops are affected by saline conditions in varying degrees. Some crops can produce acceptable yields at greater soil salinity than others. The EC is a common measure of the ions which make up the salts, ECe refers to soil salinity, ECw refers to the salinity of the water. Conversions of this measurement into other units are as follows:

1dS/m = 1000 EC units (or mS/cm) = approximately 640 mg/l (or ppm)

Saline water affects the osmotic potential of the plant root, thereby affecting water and nutrient uptake. Consequently, yields reduce as salinity increases. Ayers and Westcot’s (1994) summary of salinity work indicates that there is a 5 - 10 fold range in salt tolerance of agricultural crops. Salt tolerances of four crops commonly grown in the LMB are presented in Table 1 after Ayers and Westcot. Barley is 8 fold more tolerant of salt than beans. Rice is considered to be moderately sensitive. Rice will suffer yield reductions if the water contains salt levels above an Electrical Conductivity (EC) of 2 dS/m or if the soil contains salt above an EC of 3 dS/m. In glasshouse pot trials, rice plants are more sensitive to salt than in the field: Motamed et al (2008) considered that the threshold level for grain yield maximization was 1.3 dS/m.

Folkard and Wopereis (2000) found that yields declined about 0.6 - 1 to/ha per unit of EC for EC levels above 2 dS/m. Gratten *et a.l* and Scardaci *et al.* (1995) also considered the threshold level to be at 2dS/m above which rice yields were reduced significantly. For the Water Quality Index for agricultural use in the Mekong Delta the following yield depression figures are applied for irrigated paddy rice (MRC Technical Paper No. 19, Nov. 2008):

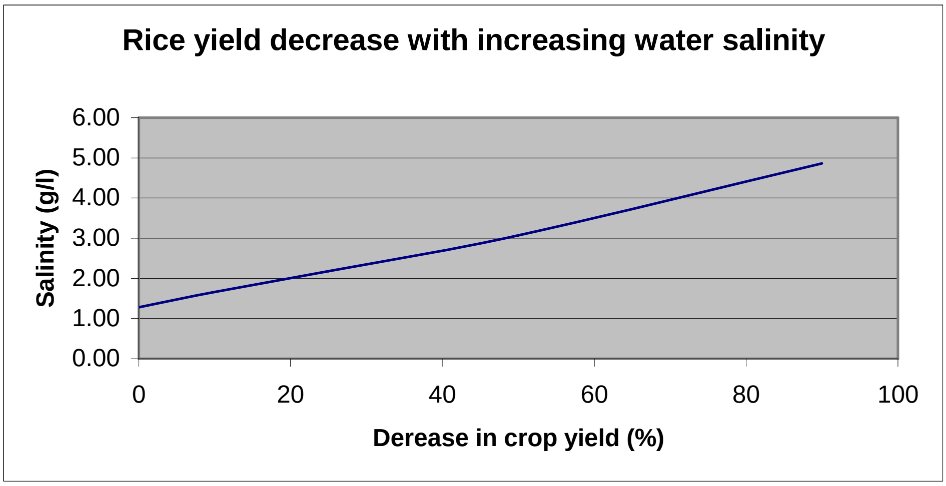
- Conductivity < 200 mS/m (= 1280 mg/l): no yield reduction;
- Conductivity between 200 and 480 mS/m (= 1280 to 3070 mg/l) yield reduction of 10 to 50%; and
- Conductivity > 480 mS/m (> 3070 mg/l): yield reduced by more than 50%.

Above given figures appears to be “on average” in line with the values given in the Table of Ayers and Westcot (1994). For rice the data in the table have been graphed in Figure 1 for convenience.

Table 1: Crop tolerance and yield potential of selected crops as influenced by irrigation water salinity (ECw) (After Ayers and Westcot, 1994)

Crop	Crop yield potential				
	100%	90%	75%	50%	0%
Barley (*Hordeum vulgare*)	<3.4	4.3	5.6	7.7	>12.2
Rice (paddy) (*Oriza sativa*)	<1.3	1.7	2.2	3.1	>4.9
Corn (maize) (*Zea mays*)	<0.7	1.1	1.6	2.5	>4.3
Bean (*Phaseolus vulgaris*)	<0.4	0.6	1.0	1.5	>2.7

Figure 1: Decrease in rice yield (%) with increasing salinity (g/l)



Studies have been conducted to overcome salinity induced losses in yield. Zeng and Shannon (2000), for example, tried to increase potential yield by increasing the seeding rate. Another method of reducing losses from salinity is the introduction of salt tolerant rice varieties. Singh (undated) reports the development of a rice variety which tolerates an ECe of 6 - 10. A program is also underway in the Mekong Delta to breed varieties which will tolerate salt levels in a similar range (Nguyen *et al.*, undated). Such varieties would move the crop further up the salt tolerance scale.

1.2 Salinity affected areas under the various scenarios

Changes in areas with salt water intrusion in the Delta have been assessed for the various scenarios applying the DSF. Figures 2, and 3 show the results for the Baseline scenario, the Definite Future scenario and the 20 Year Plan scenario, for the dry season, for an average hydrological year.

Figure 2: Salinity intrusion in the dry season in an average year, Baseline and Definite Future scenario

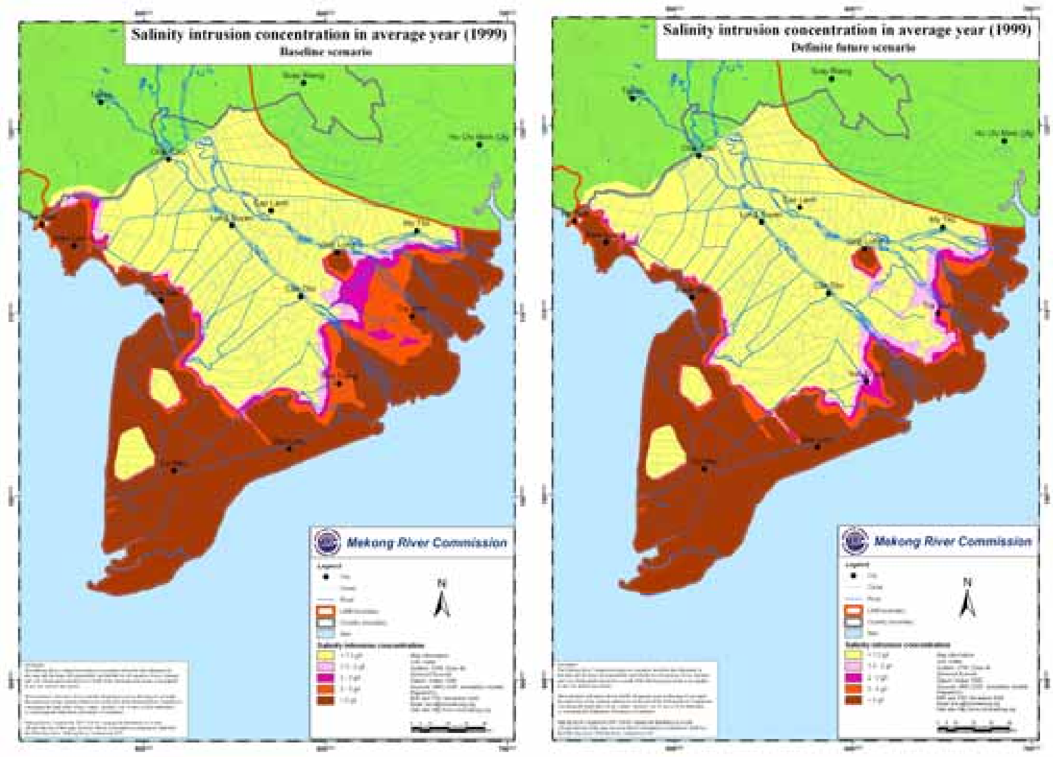
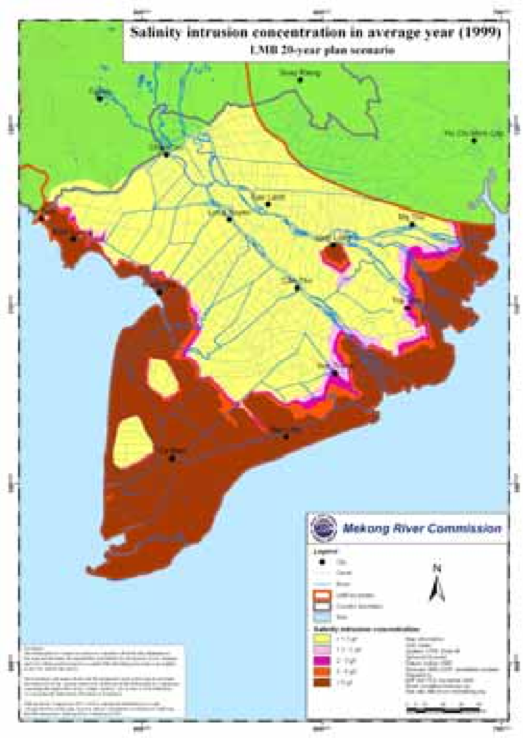


Figure 3: Salinity intrusion in the dry season in an average year, 20 Year Plan scenario



Changes in total salt effected areas for the three scenarios are summarized in Table 2. The table shows that the salt water effected area decreases considerably (with 15%) in the Definite Future scenario and reduces with another 2 percent under the 20 Year Plan scenario.

Table 2: Changes in salt water effected areas in the Mekong Delta (dry season, average year)

	Salinity concentration				Total	Percent
Salinity	1.3 - 2 g/l	2 - 3 g/l	3 - 5 g/l	> 5 g/l	area	change
Baseline	93,629	128,843	257,052	1,371,819	1,851,343	0
Definite Future	127,735	86,574	130,942	1,234,149	1,579,400	-14.7
20 Year Plan	104,564	82,301	131,276	1,224,655	1,542,796	-16.7

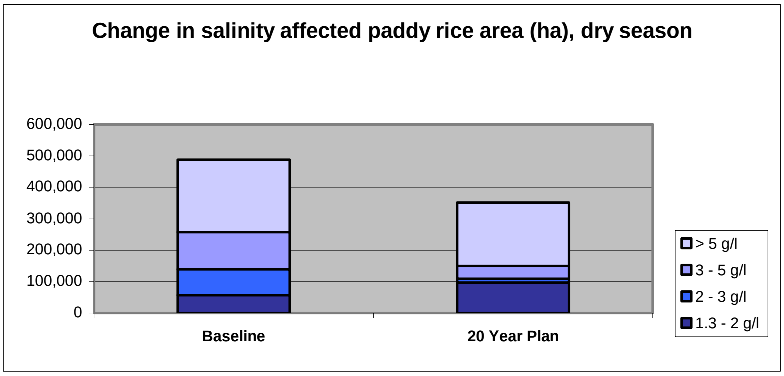
It should be noted that the areas quoted are computed as being within the salinity contours by reference to predicted salinity levels in the river channels. The land areas between the channels are serviced by off-takes at various points along the channels, which allow a degree of control over the salinity levels within the enclosed land. Thus the salinity recorded on the enclosed land may differ from that implied by the map. Hence the areas above are referred to as potentially affected.

1.3 Impacts on crop production

Salinity in the Delta waters is highest in the months March and April and therefore effects yields of the wet season (summer - autumn) crop. According to the Vietnamese Statistical Yearbooks average wet season paddy rice yield in the An-Giang province for the years 2004 – 2007 was 5.2 ton/ha. In Don Thap Province the average wet season paddy rice yield over these years was 4.7 ton/ha. Wet season rice yields in An Giang and Don Thap Province are assumed not to be affected by salinity.

To calculate the impact of changes in salinity on overall rice yields in the Delta under the 3 scenarios, overlays have been made of the dry season salinity maps (average year) and the irrigated area map. The yield depression curve given in figure 1 has been applied to calculate yield reductions of the wet season crop under each of the scenarios, assuming a maximum, not salt depressed yield of 5 ton/ha for the whole area. Total salinity affected summer-autumn crop area (for an average year) reduces from 490,000 ha under the baseline conditions to 350,000 ha under the 20 Year Plan scenario, see Figure 3.

Figure 3: Changes in salinity affected summer-autumn paddy area, for an average year



The results of the calculations are shown in table 3.

Table 3: Wet season rice production in salinity effected areas (ton) in the Vietnamese Delta

	Salinity concentration					Production in ton		
	<1.3 g/l	1.3 - 2 g/l	2 - 3 g/l	3 - 5 g/l	>5 gr/l	Total	Increase	% Change
Baseline	3,815,195	255,866	282,214	194,519	0	4,547,793	0	0.0
Definite Future	4,466,755	395,028	74,433	78,182	0	5,014,398	466,605	10.3
20 Year Plan	4,496,240	437,477	40,793	67,444	0	5,041,953	27,556	10.9
Total							494,161	10.9