The pattern of Caspian Sea penetration into the Anzali Wetland, Iran

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Abstract
Long term fluctuation of the Caspian Sea level and increase in pollution loads in the Anzali basin have dramatically influenced water quality in the Anzali wetland by increasing the extent of salt water penetration and increasing anaerobic condition at the bottom of the wetland. To understand the extent of Caspian Sea penetration into the Anzali wetland, the water salinity was measured at different depths along six transacts at the mouth of the wetland and along five tributaries connecting the wetland to the sea. The results demonstrated a depth-dependent salinity gradient extending up to 10 kilometers into the wetland. The pattern of saltwater and freshwater interface presented in this study indicates that greatest loss of water quality in the wetland occurs where the input of polluted effluent coincides with the penetration of the saline water.

Keywords: Anzali Wetland, Caspian Sea, salinity gradient.

Introduction
Although Caspian Sea water is much less saline than open sea but it is some 50 times more saline than some of the tributaries which feed Anzali Wetland. The Caspian's low salinity is due to freshwater input (Kosarev and Yablonskaya, 1994). The Volga River contributes up to 82 per cent of the inflow with the rest supplied by some 130 other rivers, principally Ural, Kura and Atrak (Dumont, 1995). The high salinity of water in some water courses in Anzali Wetland especially on stormy is been a familiar phenomenon. Early this century, Rabino the French council at Rasht reported salt water penetration in Mianposhteh (Shantia, 1988). However, a complete picture of Caspian Sea penetration into Anzali Wetland has never been reported in a scientific literature. The pattern and chemistry of the interface has shown to dramatically influence water quality (Sharifi, 1990) and nutrient cycling (Sharifi, 1989) in some parts of Anzali Wetland. Recent rise of Caspian Sea and increased pollution load in many water courses in Anzali Wetland, once more, draw attention toward the understanding and monitoring of the extent of the penetration and possible role of this phenomenon in developing increased sedimentation and enhancing anaerobic conditions created in polluted areas.

Materials and Methods
A modified Irwin water sampler was used in order to collect water at desired depth. The salinity was measured at place on a small boat using a Harris conductivity meter. The samplings were conducted at three points along six transacts at the Shipping Channel and continued along the watercourses (Fig.2) as far as the salinity at surface became similar to that of the salinity at bottom. At any sampling site the water samples were obtained from surface, bottom and mid distance between the two.

The Anzali wetland is located at south-western corner of the Caspian Sea beside the delta of the River Sepidrood. The catchments area of the wetland is about 3740 km^2, of which more than 2000 km^2 are flat terrain and the rest consists of rolling hills and mountains. The area is located between 48°46’ and 49°43’ E longitude and 36°54’ to 37°34’ Latitude. The lowland of the basin is intensively cultivated for rice and the natural cover of the upland is temperate-deciduous forest.

The area benefits from considerable precipitation and does not has a dry season. Therefore, the wetland, although experiencing some sea water penetration, is a freshwater ecosystem. The waterlogged area of the wetland varies considerably with time, and is strongly influenced by the well-known fluctuation of the Caspian Sea as dictated by the hydraulic gradient between sea and wetland. Recent evaluations indicate that since 1929 the extent of the Anzali wetland has been decreased from 300 to 100 km2 (Shantia, 1988). A recent rise of Caspian Sea level has expanded the wetland well beyond the pervious circumference, around which considerable land has been drained and cultivated during the last two decades.

Results

Fig.1 demonstrates the variation in electrical conductivity of water at three different depth on the five tributaries (Shanbeh Bazar Roga, Nahang Roga, Rassteh Khaleh Roga, Pir Bazar Roga and Ssossar Roga) of Anzali Wetland. Fig.2 provides the extent of salt water penetration into Anzali wetland on the basis of salinity values at bottom. Values obtained for conductivity of water at surface in all sampling sites showed small variations extending from 1000 micromhos in most remote sections of the wetland to 5000 micromhos at the end of the Shipping Channel which is in close proximity to the sea water. In contrast to the surface water, variation in values obtained from various depth at different sampling sites were considerable. The extent of the variation is caused mainly by depth of the water courses rather than by distance from the sea. The pattern of saltwater penetration into Anzali Wetland indicates that although a salinity gradient persists in Anzali Wetland but the stratification between waters with different salinity fade out as one moves from the sea into the wetland. With the diffusion of the sea water driven partly by difference in density of salt water along the watercourses and by the decline of wave action, the differences between salinity decreases until becomes equal at all depths. Differences between salinity at surface and in depth increase until the end of the diffusion zone in which salinity values decline sharply and finally become alike.

Discussion

Low level of water discharge from the water courses together with low salinity level of Caspian Sea are the main reasons for absence of typical rigid halocline as is normally seen in some lakes or estuaries. Moreover, although powerful waves action are partially controlled by long weirs build at the sea shore but the waves can disturb any salinity gradient far into the water courses. This is especially significant on stormy days. In one such situation at Shipping Channel the salinity at surface water was measured to be 7000 micromhos some 60 per cent higher than average values in a normal day.

Relationships between depth and salinity are shown in Fig.3. This figure is based on information obtained on all sampling sites. However, information obtained from the Shipping Channel which is common in all watercourses is considered here once in order to prevent overrepresentation of the data. The general relationship between depth and salinity does not follow a linear pattern because other factors such as distance from sea, direction toward the sea and topography at water course bed are to some extent influential to the amount of salinity. For example Shanbeh Bazar water course which is the closest water course to the sea has a linear relationship between salinity and depth with higher coefficient of variation. Similarly, Sossar water course which is farthest of all water course to the sea has a very weak correlation between depth and salinity.

It has been reported that the rate of sedimentation in Anzali wetland is unusually high (Shantia, 1989). This has been inferred on the basis of rapid filling of sediment traps constructed in the inner parts of the wetland (Shantia, 1989). It has been shown that salt water may influence the rate of sedimentation by various mechanisms. In a dilute colloidal suspension the suspended solids in water remain in complete dispersion. In this situation, the particles tend to repel each other, permitting each particle to act independently of the others. Dispersion of particles is encouraged by higher pH values and the size and nature of the colloidal particles. Moreover, the amount of multi charged ions, more tightly adsorbed by a micelle together with contraction of micelle, and temperature are other factors which can control electro negativity in a solution.

Although highly mono valent ions such as Na+ which are not very tightly held by the micelle, are dominant in sea water, but constant collision of saltwater and freshwater has a significant role in flocculation of suspended solids coming from basin to the sea. Overbick (1990) showed that sedimentation at the mouth of estuaries is to large extent due to flocculation of suspended materials under influence of sea water electrolytes. The presence of a saltwater layer beneath the freshwater in Anzali Wetland may have encouraged sedimentation in some parts of Anzali Wetland. The catchments area of Anzali Basin is relatively small (3470 km2) and total suspended solids in various part of the wetland are not characteristically high (Shantia, 1989) yet there are reports of accelerated sedimentation in the wetland. Further investigation is necessary for clarification of the sedimentation under influence of different waters with various salinity.

The ways Caspian Sea penetrate Anzali wetland differ in many respects to that of estuaries. Absence of the tidal fluctuation characterises the interface between freshwater and sea water. In estuaries the tidal fluctuations are Important ecological factors in providing energy, nutrient and reducing the community respiration. In wetlands that interface with open sea the easy access to nutrient and energy from sea water together with the regular fluctuation in the physical conditions provides a environment in which an orderly process of community development is not possible. Therefore the system remains more or less ecologically young and simple. Certainly, prolong condition governing the estuarine environment has evolutionary significance and causes peculiar adaptations for life in the tidal zone. Generally, plants and animals living in these environment have broad ranges of tolerance to extreme physical conditions.

Tidal fluctuation in the Caspian Sea is not sensible and probably is biologically insignificant. In the absence of a turbulent interface and the tidal zone the Caspian Sea interface is characterise by a consistent halocline which remains calmly beneath the freshwater. The presence of a constant layer of saline water in parts of Anzali wetland may cause some nutrient being transported to the wetland but unlike open sea can’t help to reduce the community respiration by removing unwanted material to the sea.

The halocline in Anzali wetland is under influence of wave actions, long term fluctuation of the Caspian Sea and the annual cycles in freshwater discharge from the Anzali basin. There in no evidence supporting the development of any character rising under the selection values along the halocline. It is more probable that factor compensation takes place along the halocline in the form of species composition change. Compensation along the salinity gradient may also involve development of genetic races or ecotypes. Further investigation for recognition of community characteristics and variation in individuals are recommended in and around the interface.

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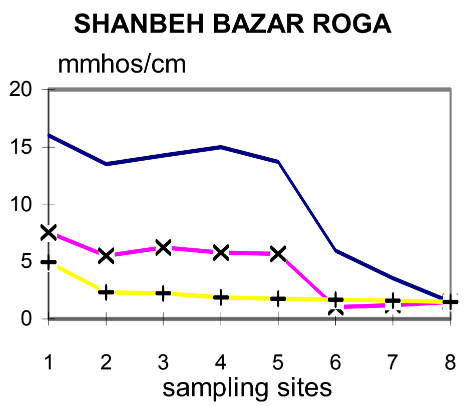

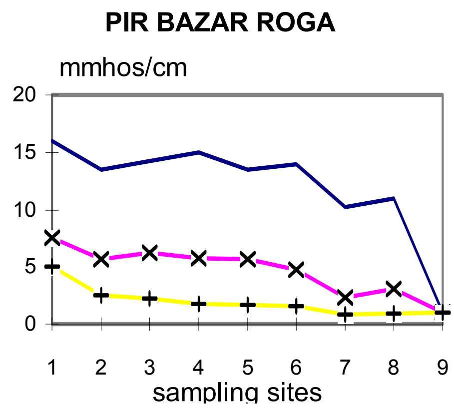

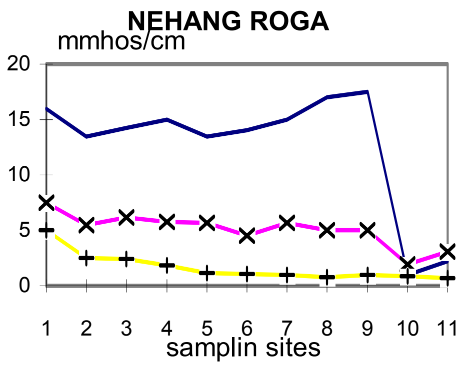

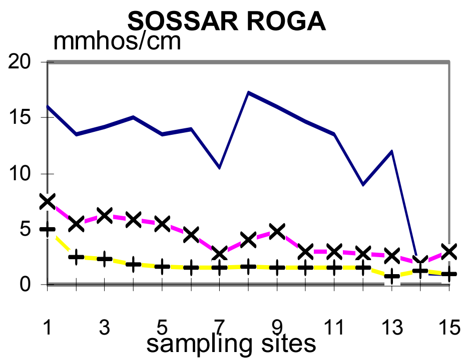

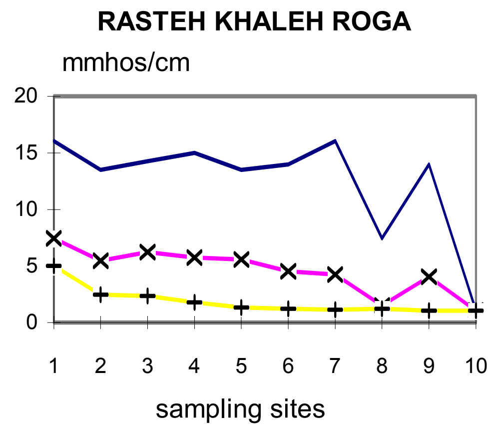

Fig.1. Electrical conductivity of water at surface (-), bottom (×) and mid-depth (+). Distance between each sampling sites is roughly 400 metres.

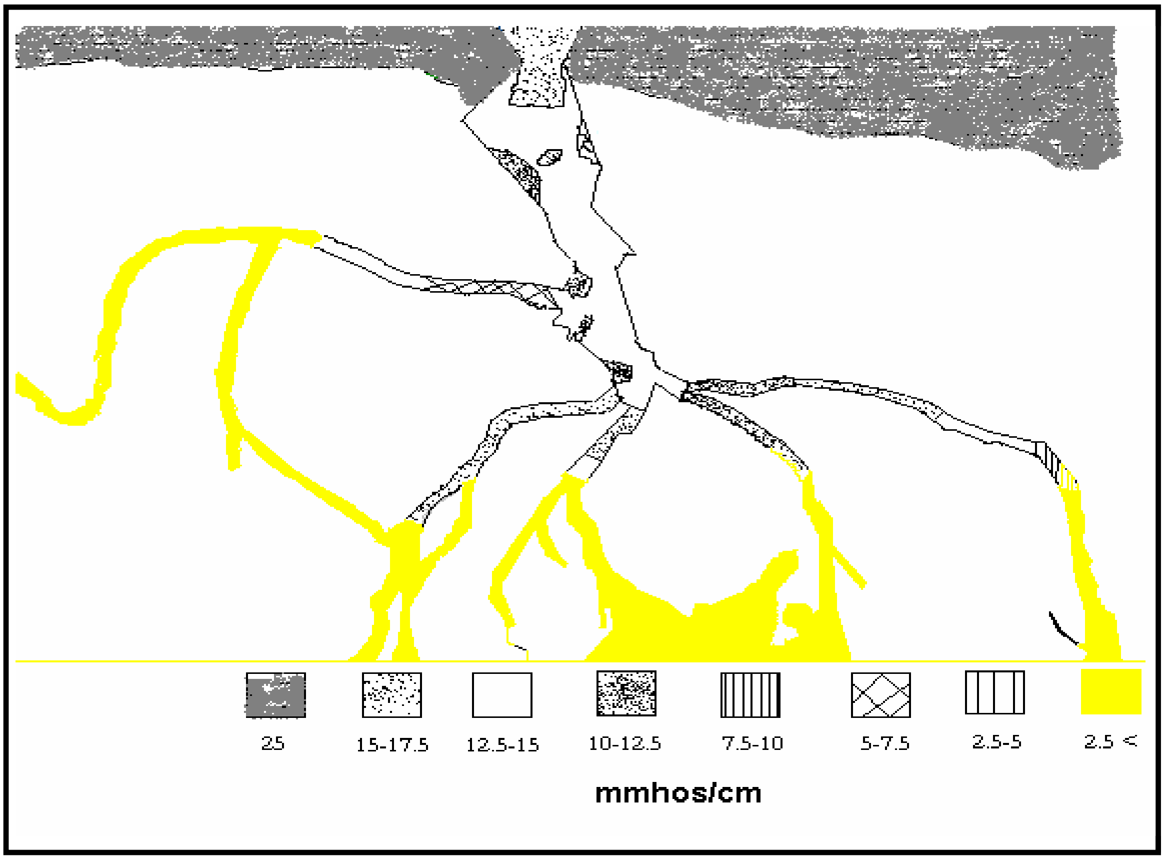

Fig 2. A pattern of salt water penetration into Anzali wetland on the basis of the salinity measured at bottom.

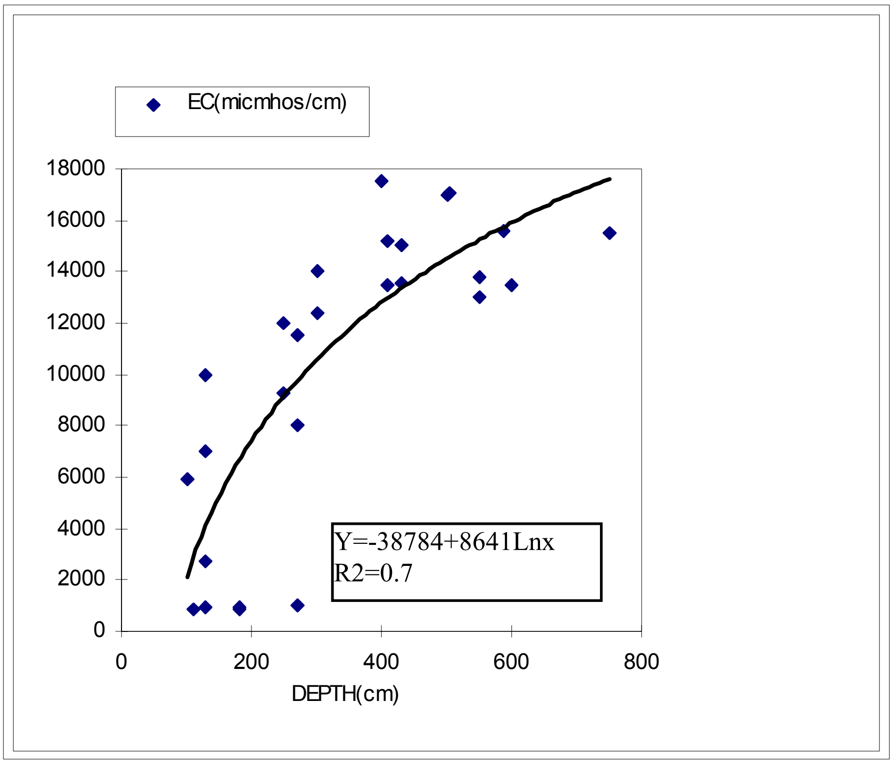

Fig.3. A regression analysis between depth and salinity at depth at various sampling site in Anzali Wetland.