AGRICULTURAL DRAINAGE WATER IN THE CASPAIN SEA AND THEIR ECOLOGICAL IMPACTS

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Abstract

The existing system of management and development of irrigation and drainage and sectors of the economy on the coast by small landholders without consideration of the ecological danger have led to disruption of the ecosystem balance and change in structure of the environment. The existence of many rivers draining into the Caspian Sea, and uncontrolled utilization of pesticide toxicants, are one of major concern regarding the water resources in the north provinces of Iran. A study have been done for measuring of Organochlorine and Organophosphorus pesticides in nine rivers of the Caspian Sea basin in Mazandaran and Golestan provinces which include Haraz, Babolroud, Talar, Tajan, Siahroud, Gharahsoo, Nekaroud, Gorganroud and Atrak from Apr 2005 to Mar 2006. Samples analyzing revealed that Phosphorous toxin are observed frequently in aquatic ecosystems especially in autumn. Diazinon as a Phosphorous pesticide almost was found in all rivers during the year and its concentration is somewhat more than others. On the other hand, chlorinated pesticides are observed frequently in spring and especially in summer and did not find in winter at all. Due to the vast expansion of agricultural fields in the study area, these contaminants are leached by rainfall, irrigation and drainage activities and then are conducted to the rivers and finally into the Caspian Sea. As chlorine toxins are lasting carbocyclic compound, they can concentrate in the fat tissues of some important species and under CITES list such as Caspian Seal (*Phoca caspica*) and sturgeon (Acipenseridae) and certainly endanger them in long-term. Thus, development of irrigation and drainage efficiency and some environmental observations under the small land holding condition could be diminish the negative impacts and consequently maintain the ecosystem balance in this region.

Keywords: Caspian Sea, Caspian Seal, Sturgeon, pesticides, Mazandaran and Golesatan,

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INTRODUCTION

The Iranian coast of the Caspian Sea stretches for nearly 700 km from Azerbaijan in the west to Turkmenistan in the east .This coastline is now becoming increasingly polluted with massive loads of contaminants discharged into the Caspian Sea from various anthropogenic sources. The areas of river mouths, water areas near human settlements and agricultural fields are the most heavily polluted areas.

Data of the toxicological survey of bottom sediments obtained during the expedition conducted under the CEP indicated the increased content of different compounds of Organochlorine pesticides near the coast of Azerbaijan and Iran which attributed to their application in agriculture, rice growing in particular.Motavalli (1999) reported that the World Bank estimated that a million cubic meters of untreated industrial wastewater is discharged directly into the Caspian Sea. The reported by Neville mentioned scientific estimates of annual averages of 24,000 tones of sulfites, and 400,000 tones of chlorine. Sea currents transport and circulate the entrapped pollutants along the Iranian coast of the Caspian Sea. The chemicals and pesticides are threats to the flora and fauna.

One example of detrimental impacts on aquatic life could be found in the account by Energy information Administration (2003) which reported that thousands of seals that live in the Caspian Sea have died since 2000 because of the consequence of pollution that affected their immune system. According to the Caspian Environmental Program (CEP), sturgeon landings have decreased from 30,000 tons in 1985 to only 5,672 tons in 1995. The existing and potential problem to aquatic and human life from toxic pollutants, therefore, requires investigating the current concentration of contaminants in the studied area.

MATERIALS AND METHOD

We have categorized the study area to 6 subareas including Haraz, Talar, Tajan, Neka, Gorgan and Gomishan (Figure 1). Haraz subarea includes Haraz and Babolroud river,

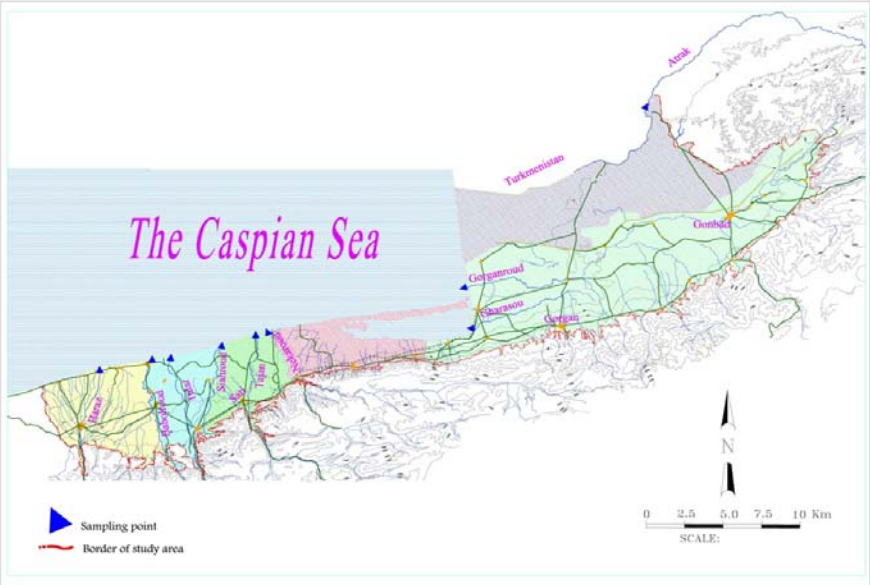

Fig 1. Border of study area and sampling points

Talar includes Talar and Siahroud river, Tajan includes Tajan river, Neka includes Nekaroud river, Gorgan includes Gorganroud and Gharasou river and Gomishan includes Atrak river. This study was done for measuring Organophosphorus and Organochlorine toxine in Mazandaran and Golestan rivers since April.2005 to March.2006. All stations were chosen near estuary, namely after ending of farm and agriculture fields in order to establish an equal condition in sampling. Sampling was being done monthly and sampled from middle across and depth of the rivers. Two samples were always gotten in each station to avoiding the shortage of sample volume, and were sent to laboratory for analyzing immediately. Both groups of pesticides were measured by specific method and instrument. Organochlorine pesticides were analyzed by means of Flane ionization detector (FID) and gas chromatography and Organophosphorus pesticides were analyzed by means of Nitrogen-phosphorus detector (NPD) and gas chromatography. Identification and measurement of Organochlorine & Organophosphorus pesticides were done by standard stop time toxicants and calibration curve graph.

RESULTS

In this research we have studied two groups of toxins including Organophosphorus & Organochlorine pesticides. Organophosphorus pesticides include Diazinon, Choloropyrfos, Ethion, Endifenphos, Azinphos-methyle and Organochlorine pesticides include δ-HCH, Dieldrin, 2-4DDE, 4-4DDE, 2-4DDT and 4-4DDT. These pesticides are mainly used as fungicides, Insecticides and herbicides throughout agricultural lands. Both pesticides are used for different products including rice, orange, orchard and etc (Figure 2).

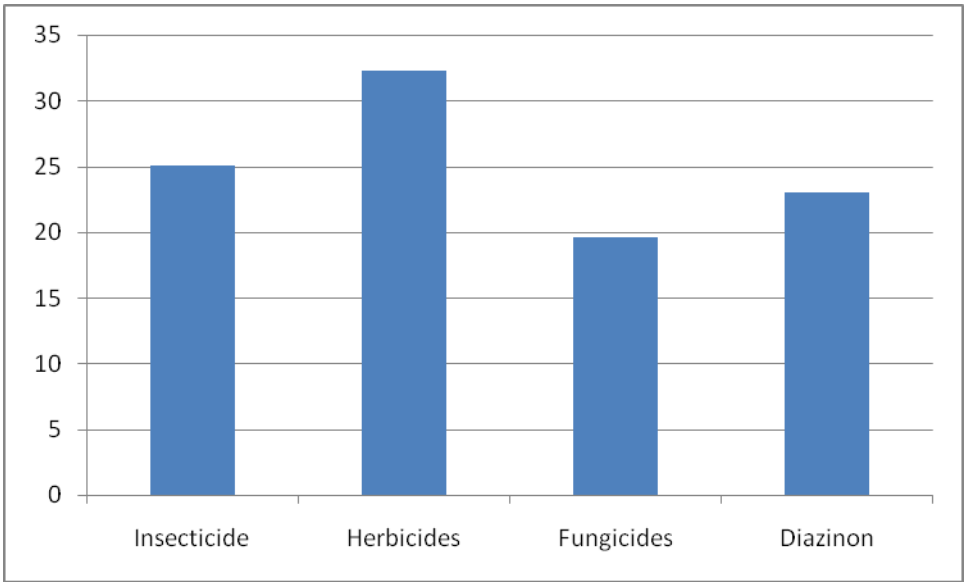

Fig 2. Amount of different distributed pesticides in Mazandaran & Golestan provinces in 2009

The residence time of total DDT in the environment is relatively short ($t_{1/2}$=3-5 years), so at least 75-80% of the current total DDT should be in the form of DDE or DDD if it was introduced into the environment before the 1985 ban. Values of Henry's law constant indicate that these compounds can reach the troposphere as vapor. These vapors are little absorbed by airborne particulate matter and represent the major

component in atmospheric chlorinated hydrocarbon levels. DDT concentration in surface water is function of soil and rainfall. Thus, vapor movements of these pollutants suggest that restrictions and regulations operating in the more technically advanced countries could only be partially effective on a worldwide basis.

In contrast to Organochlorine, Organophosphorus pesticides have not long residence and decay after 20-25 days of spraying.

Diazinon is an Organophosphorus which was observed in all rivers during the year and its concentration is more than EPA standard in all stations. This toxin is used throughout the year, but maximum concentrations are usually observed in summer. For instance, in Haraz river, Diazinon concentration in summer is 16 times of autumn; but we can observe relatively steady concentration in Atrak river during the year. These differences reflect diversity of land use. Other Organophosphorus including Ethion, Choloropyrfos and Endifenphos had less frequency than Diazinon respectively. Nevertheless, Azinphos-methyle wasn't observed in any sample at all. DDT has different derivatives such as DDD and DDE. Among DDT group, 2-4DDE and 2-4DDT have maximum and minimum frequency in samples respectively.

A study by Nazari (1996) showed that a wide variety of Organochlorine pesticides are used throughout of Mazandaran and Golestan provinces from April-May in contrast with January-February by the least application. Mixed vapor with DDT in agricultural fields can remain for 6 months in atmosphere. Most DDT in sprayed area deposit in soil and logarithmic decrement is observed from pollution source. DDT transportation is much in air and can transport to thousand kilometers and reach to ground by rainfall again.

Rice growing is a common product in area and varied pesticides are used in different stages of its growth. For example, Diazinon and δ-HCH are mainly used for annihilating of rice pests. It is obvious that climate condition, quality and quantity of water are main effective factors in forming of crop pattern. For instance, by leaving from Haraz to eastern part of the area, water quantity decrease and in Gorganroud and Atrak we have the main water shortage. This phenomenon has important impact on crop pattern. About 97% Lands adjacent of Haraz and Babolroud contain rice paddy field and only 3% allocated to non-paddy (Figure 3).

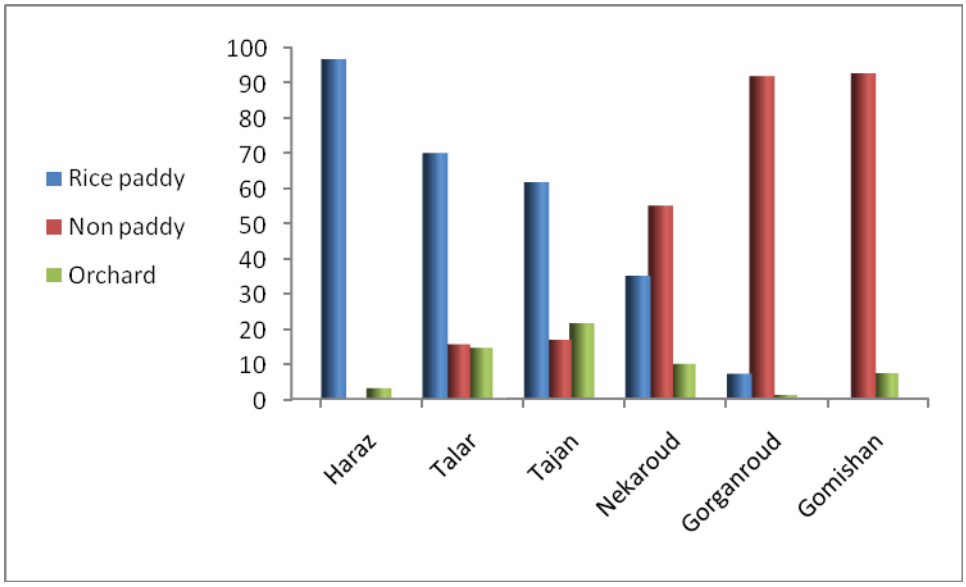

Fig 3. Cropping pattern in different parts of the study area

Whereas in Atrak and Gorganroud in the east of study area, 90% of lands have allocated to non-paddy products such as cotton, bean, soya, wheat, tobacco and so on. In comparison with rice paddy fields, these products have less water requirement.

DISSCUSSION AND CONCLUSION

DDT is a lipophilic compound and accumulates in fat tissues of plants and animals. DDT usage has banned since 1985 in Iran, but still is observed in environment due to its high residence time. On the other hand, this pesticide smuggle to the country as ant toxin.

In summer, Diazinon concentration is more than other seasons due to more usage in rice paddy. During this study we observed maximum concentration of Diaznion in Haraz river so that this region mainly allocated to rice paddy. In region such as Haraz that main product is rice, amount of Diazinon usage naturally is maximum level in order to decay of rice pesticides. Finally these pollutants discharge to water bodies including surface and even underground reservoir. For instance, a study by Yousefi(2008) about pesticides in 12 city of Mazandaran province have shown underground water in Amol (adjacent Haraz river) had maximum level of Diazinon than others. By rice harvesting this pesticide is used for spraying of orange and orchards pest again.

Similar to Diazinon, Organochlorine pesticides have maximum level in summer and winter has minimum level in so far as we observed ND concentration in all rivers. Among the rivers, maximum and minimum Organochlorine pesticides were measured in Tajan and Talar respectively. During this study, all Organochlorine measurements were ND in Talar river.

Residence time of Organophosphorus is less than Organochlorine, but their toxicity is more acute for biota. For example, according to EPA standard, maximum concentration of 4,4-DDT and 2,4-DDT is 0.1 ppm and 0.113-0.8 mg/l respectively, but maximum allowable level of Diazinon is determined o.oo1 ppm. Although Diazinon is a low residence time, but by discharging to aquatic ecosystem can cause acute effect in short -time. For instance, LC50 of DDT and Diazinon are 250 mg/l and 125 mg/l for Carp respectively. Namely lethal effect of Diazinon is 2 times of DDT for Carp.

As Organochlorine pesticides were used in past time, we conclude they can transfer to fish bodies by means of food chains and their concentrations always are more than their surrounding environment. For instance, in this study we measured total DDT concentration of 4 fish species (Barb, Pike, Mullet and Carp) in Siahroud river concurrently in summer which showed 0.5, 0.16, 0.14 and 0.39 mg/l respectively. That same time DDT concentration was o.o26 mg/l in water which reflected Bioaccumulation Factor (BAF) about 19, 6, 5 and 15 times in mentioned species respectively..

Concentration of Organochlorine pesticides including Dieldrin, Aldrin and DDT was measured in muscle tissues of stellate sturgeon (*Acipenser stellatus*) of southern coasts of the Caspian Sea by keshavarzi fard (2008). Comparison of measured concentrations with Maximum Residue Limit (MRL) established by FAO/WHO showed that the average concentration of DDT in samples from Bandare Turkman (Gorganroud river estuary) exceeded the MRL value.

On the other hand, a study by Natsuko Kajiwara (2008) showed DDTs were the predominant contaminants that ranged from 3.1 to 560 μg/g in the blubber of Caspian seals, which died during an outbreak of canine distemper virus in 2000 and 2001.The levels of pesticides in Caspian seals, however, comparable to those in other aquatic mammals that have suffered from epizootics, might pose a risk of immune suppression.

Finally, the use of environmentally harmful pesticides in small-scale farming along the Caspian coastline and river deltas has been identified as a serious threat to aquatic biodiversity in the region. In order to reduce the discharge of toxic and bio-accumulative substances into coastal waters, legislative enforcement must be strengthened. As suggested former, the sale and use of DDT has been legally prohibited in Iran for 2 decades but the supply is still abundant throughout the area. To better enforce the ban on DDT, regional control functions need to be strengthened and local officials must be given the necessary resources to control local market supply and sale. The feasibility and effectiveness of improved legislative enforcement are expected to be high since forbidden chemicals are easy enough to identify and confiscate. Responsibility for improved enforcement should be given to local and municipal authorities. A recommended parallel measure is to provide local farmers with economically viable alternatives to DDT. This could be done by reducing import taxes on modern and less environmentally harmful pesticides. Modern pesticides are generally more expensive than DDT on the local markets and, therefore, can not compete with traditional products. Tax reductions could reduce the prices of modern pesticides substantially, but it is unlikely that prices can drop enough to compete with the very cheap chemicals currently in use. The short-term effectiveness of a state-driven substitution of obsolete pesticides is hence expected to be fairly low. This measure is however still recommended as a long-term policy. Since the public awareness of the ecological consequences of the use of toxins is rather low in the region, educational efforts would complement the 2 top down measures suggested above. Special training, lectures, and educational TV programs need to be developed and offered both to authorities and local communities in the region. A better public understanding of the ecological vulnerability of the Caspian waters can in the long run increase local engagement in the regional environment. Educational policies are hence recommended on a broad scale in all 5 littoral countries. So that the Caspian Sea cannot be divided into separate compartments; what affects one part of the sea may affect all parts, since all parts are linked. The sea itself is a unique body of water which is of global significance. Concerted action in marine monitoring and management therefore has the potential to deliver the greatest benefits to all participating states.

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