

# SOCIO-ECONOMIC IMPACT OF CLIMATE CHANGE IN ARAL SEA BASIN

G. M. Shah

## **Abstract**

*The global warming as a result of climatic change is one of the widely discussed environmental issues of the present day world. The environmentalists, policy-makers and other concerned national and international agencies as well as other relevant organizations have discussed the problem from time to time with different perspectives. The problem has been linked mainly to the issues of desertification, uneven economic growth, problems of human security, loss of biodiversity and unscientific resource development. Being a grave issue having far reaching consequences, there is, therefore, a genuine need to comprehend the problem in a more scientific manner. The proper handling of the subject requires expertise, technological advancement, proper tools and techniques of data collection and analysis as well as resources. There are many pressing environmental issues facing the world today which include the ozone layer depletion, deforestation, land degradation, pollution and global warming. The climate change responsible for global warming, has been caused due to both natural and anthropogenic causes. The natural causes are by and large a universal phenomenon, but anthropogenic causes vary in nature and intensity from continent to continent and region to region. There are many environmental issues in Asia but the problem of Aral Sea desiccation and the resultant climate change in Aral Sea Basin is one of the serious environmental challenges of Central Asia which requires attention by the climatologists, environmentalists and geographers. The present study is an endeavor to examine the climatic change within Aral Sea Basin and the socio-economic impact the region has impeded.*

## **Keywords**

Climatic Change, Global Warming, Anthropogenic Causes, Aral Sea Basin, Environmental Refugees, River Catchment, Glacial Phases, Aral Desiccation, Geological Eras, Socio-economic Impact, Environmental Issues, Regional Biodiversity, Water Management.

## **Aral Sea: Origin and Evolution**

The formation of the Aral Sea began at the end of the last ice age, about 20,000 years ago. The first waters to enter the region were probably that of the Scandinavian ice sheet which was thought to cover certain parts of Ural Mountain in Russia. Here glacial melt water from Alpine glacier filled this land locked area. The filling up of water increased significantly during the late Pleistocene and early Holocene era when the depression in the basin was formed. The uplift of the earth's crust is referred to as epeirogeny which is associated with the movement of plate interiors responsible for forming basins and plateaus. As per the Anderson, the Aral Sea falls under the category

of pluvial lakes, which essentially are “bodies of water that form because of additional moisture availability following changes in temperature and precipitation.” It is, therefore, assumed that this lake filled up during periods of higher rainfall. There is general agreement within the scientific community that “during glacial periods at higher latitudes, lower latitudes experience periods of abundant moisture, and during post-glacial times these arid parts of the world became characterized by desiccation.” Other natural phenomena associated with greater water availability have been shown to correlate with sun spot minima’s. There are periods when less solar energy reaches the earth causing less evaporation, thus, leaving more available moisture on the ground. Sun spot minima’s seem to have affected water inflow into the lower latitudes between the 13<sup>th</sup> and 18<sup>th</sup> century.<sup>1</sup> Tectonic uplift is another natural component resulting in the creation of the Aral Sea. During the early to mid Pleistocene era, mountain ranges rose 2000 to 2500 m creating glaciations due to their height in elevation, leaving the area with reserves of water to be used in future when warmer temperatures introduce themselves to create melt water.

Another environmental factor is said to be a change in wind direction from a westerly flow to a meridonal and mainly easterly flow. This change is thought to have occurred in the early 1930’s around the same time as the great dust bowl in the United States. For the area within the Aral Sea Basin this meant an increase in anticyclone activity especially during the winter months, resulting in harsher environmental conditions creating more dry conditions for this area. Some studies show that the Aral Sea recovered from a period of complete desiccation between the late Pleistocene to early Holocene. Based on geological and historical investigations, most researchers have come to the almost unanimous conclusion, which was well formulated by N.V. Aladin, stating that in prehistoric times, changes in Aral Sea level and salinity took place due to natural climatic changes. During the humid climatic phases the Syr Darya and Amu Darya were abounding in water and the lake reached the maximum level of 72 to 73 m + BSL. As per the recent radiocarbon measurement of bottom sediments the Aral Sea has undergone five to seven transgressions out of which the strong ones formed the highest terraces (elevations 72 to 73m + BSL), pertaining obviously to the early Pliocene. The earth’s climate has undergone significant and highly variable changes over an extensively long period of time. It has experienced both stadials (cold phases) and inter- stadials (warm phases) and post-glacial periods also experiencing their own set of stadials and inter-stadials. It is, therefore, not surprising to learn that the Aral Sea fluctuated quite naturally with alterations of high water and desiccation.<sup>2</sup>

### **Geo-physical Setting of Aral Sea Basin**

The Aral Sea basin which sprawls over almost the entire area of post-Soviet Central Asia, is located in the heart of Eurasian continent. More specifically, the Aral Sea Basin covers the whole territory of Tajikistan, Uzbekistan, the large part of Turkmenistan, three provinces of Kyrgyzstan (Osh, Jalalabad and Naryn), and two provinces i.e. Kyzyl Orda and South Kazakhstan, and northern part of Afghanistan and Iran. The territory of Aral Sea Basin extends between 33<sup>o</sup>N to 52<sup>o</sup>N latitude and 56<sup>o</sup>E to 78<sup>o</sup>E longitude, covering an area

of about 1.55 million Km<sup>2</sup>, out of which about 0.59 million km<sup>2</sup> are cultivable lands.<sup>3</sup> The territory of Aral Sea Basin can be divided into two main zones: the Turan plain and the mountain zone. The Kara Kum covers the western and Kyzyl Kum the north-western parts of the Aral Sea Basin within the Turan plain. The eastern and south-eastern parts are situated in the high mountain area of Tien Shan and Pamir ranges. The remaining part of the basin comprises various types of alluvial and inter-mountain valleys, dry and semi-dry steppe. About 90 percent of the territory of Kyrgyzstan and Tajikistan are occupied by mountains. About 50 percent of the territory of Kazakhstan, Turkmenistan, and Uzbekistan are covered by desert while only less than 10 percent by the mountains.<sup>4</sup> The Aral Sea Basin experiences continental type of climate, with low and irregular precipitation. Large diurnal and seasonal temperature differences are characteristic feature of the region. High solar radiation and relatively low humidity is found in the basin. Diverse terrain and altitude differences from 0 to 7,500 m above sea level lead to a great diversity of micro climate. The average July temperature on the lower elevations in valley area and desert varies from 26<sup>o</sup>c in the north to 30<sup>o</sup>C in the south, with maximum temperature up to 45-50<sup>o</sup>c. The average January temperature varies from 0<sup>o</sup>c in the south to -8<sup>o</sup>c in the north with absolute minimum upto -38<sup>o</sup>C. The annual precipitation in the lowland and valleys is between 8-20 cm, concentrated in the winter and spring. The precipitation in the foothills is between 30-49 cm. On the southern and south-western side of the mountain ranges, it varies between 60 to 80 cm.<sup>5</sup>

There are two major river basins located in the Aral Sea Basin, the Syr Darya in the north and the Amu Darya in the south. The Zeravshan river, a tributary of the Amu Darya, stands in between these two rivers. The Syr Darya with a total length of 3019 km, is the longest river of the Aral Sea Basin. It has a catchment area of 219 thousand km<sup>2</sup>. Its head waters lie in the central Tien Shan mountains. The water regime is characterized by a spring-summer flood, which begins in April. The largest discharge is in June. About 75.2 per cent of Syr Darya runoff originates from Tien Shan mountains of Kyrgyzstan. The Syr Darya then flows across Uzbekistan and Tajikistan and discharges into the Aral Sea. About 15.2 per cent of the flow of Syr Darya is formed in Uzbekistan, about 6.9 percent in Kazakhstan and about 2.7 percent in Tajikistan.<sup>6</sup> The Amu Darya is the biggest river in Aral Sea Basin in terms of water availability. Its length from the head waters of the Pyandzh to the Aral Sea is 2400 km, with a catchment area of 309 thousand km<sup>2</sup>. It is termed as Amu Darya from the point where the Pyandzh joins with the Vakhsh. Three large right tributaries (Kafirnigan, Surkhan Darya and Sherabad) and one left tributary (Kunduz), flows into the Amu Darya within the middle reach. It is fed largely by water from melted snow, thus maximum discharges are observed in summer and minimum in January-February. Such water flows are very favourable for use of the river water for irrigation. While crossing the plain from Kerky to Nukus, the Amu Darya loses a large part of its flow through evaporation, infiltration and withdrawal for irrigation. About 74% of the Amu Darya originates from Pamir mountains in Tajikistan. The river then flows along the border between Afghanistan and Uzbekistan across Turkmenistan territory and then again diverts to Uzbekistan where it discharges into the Aral Sea. About 13.9 per

cent water of Amu Darya is formed on Afghan-Iran territory while about 8.5 percent in Uzbekistan.<sup>7</sup>

The total mean annual flow of all rivers in the Aral Sea Basin is estimated at about 116 km<sup>3</sup>. This amount comprises the flow of the Amu Darya at 79.4 km<sup>3</sup>/year and the Syr Darya at 36.6 km<sup>3</sup>/year. In accordance with flow probabilities of 5 percent (high wet years) and 95 percent (dry years), the annual flow ranges from 109.9 to 58.6 km<sup>3</sup> in case of Amu Darya and from 51.1 to 23.6 km<sup>3</sup> with respect to Syr Darya. The ground water resource of the Aral Sea Basin can be divided into two parts, the natural flow from mountainous and water catchment area and ground water originated by filtration from hydro-technical structures and irrigated land. Estimated regional ground water extraction in the Aral Sea Basin is about 10.0 km<sup>3</sup>. In case of Amu Darya Basin the annual return water, consisting of drainage and waste water from irrigation, industry, and municipal users have varied between 28 km<sup>3</sup> and 33.5 km<sup>3</sup>. While 13.5 to 15.5 km<sup>3</sup> has been recorded in Syr Darya Basin. The total amount comprised about 95 percent of drainage water and about 5 percent of untreated domestic and industrial waste water. The large percentage of drainage water demonstrates that irrigation actually consumes only about 45-50 percent of total withdrawals.<sup>8</sup> More than 80 water reservoirs were constructed in the Aral Sea Basin, each with a capacity of over 10 million m<sup>3</sup>. In order to modify natural river flow patterns to those needed for water supply, water storage reservoirs were constructed either on rivers or on main canals. The aggregate capacity of these water reservoirs exceed 60 km<sup>3</sup>, of which about 44 km<sup>3</sup> is useable, including 17 km<sup>3</sup> in the Syr Darya Basin.

### **Water Resources of the Basin**

The Central Asian countries are highly interdependent in their utilization of water resources. Most of the water in the Aral Sea Basin (upto 80%) flows from the upstream rivers in Kyrgyzstan and Tajikistan. The total mean annual flow of all rivers in the Aral Sea Basin is estimated at about 116 km<sup>3</sup>. This amount comprises the flow of the Amu Darya at 79.4 km<sup>3</sup>/year in accordance with flow probabilities of 5 percent (high wet year) and 95 percent (dry years) while the annual flow ranges from 109.9 to 58.6 km<sup>3</sup>/year for the Amu Darya and from 51.1 to 23.6 km<sup>3</sup>/years for the Syr Darya.<sup>9</sup>

**Table 1**  
**Surface Water Resources in Aral Sea Basin**  
**(mean annual runoff km<sup>3</sup>/year)**

Country	River Basin		Total Aral Sea Basin	
	Syr Darya	Amu Darya	Km <sup>3</sup>	%
Kazakhstan	2.516	-	2.516	2.2
Kyrgyzstan	27.542	1.654	29.196	25.2
Tajikistan	1.005	58.732	59.737	51.5
Turkmenistan	-	1.405	1.405	1.2
Uzbekistan	5.562	6.791	12.353	10.6
Afghanistan & Iran	-	10.814	10.814	9.3
<b>Total</b>	<b>36.625</b>	<b>79.396</b>	<b>116.021</b>	<b>100</b>

*Source: Central Asian Interstate Water Commission*

### **Causes of Aral Desiccation**

There are a number of causes responsible for desiccation of Aral Sea Basin which include both natural as well as anthropogenic forces, summarised as under:

#### ***Natural Causes***

Climate change in the form of higher temperatures, changing rainfall patterns and more violent weather has affected Central Asian region. The primary cause of climate change and increasing amounts of greenhouse gases in the atmosphere is being witnessed. The increase in annual average temperature in basin has been recorded between 1.5<sup>0</sup>c to 2<sup>0</sup>c owing to emission of greenhouse gases and drying up of the Aral Sea.<sup>10</sup> The climate change in Aral Sea Basin has partly led to Aral Sea desiccation, deglaciation of mountain glaciers, desertification, shrinkage of agricultural fields, negative consequences for agricultural sector, human health and biodiversity. In 1960 the water level of Aral Sea was 53.4 m and its water surface area was 69.79 thousand km<sup>2</sup>. In 2009 the water level of Aral Sea reached to 27.53m and its water surface area reduced to 13,500 km<sup>2</sup>. The water volume of Aral Sea decreased from 1056 km<sup>3</sup> in 1960 to 105 km<sup>3</sup> in 2009.<sup>11</sup>

The early 1960s appear to be the turning point for the regression of the Aral Sea. There is speculation that solar induced climate change is partly responsible for the regression of this water body. Study research have shown that the sun goes through cycles of rotational speed typically changing every 11 years over 80 to 120 years. This is referred to as the Solar Wolf Gleissberg Cycle (SWG C). The effects of these cycles appear to affect the earth's climate when the cycles reach their turning points. One of the maximum turning point for the SWGC is said to have happened around 1957-1959 and is referred to as the maximum of cycles designated as 'Number-19'. The premise is that solar induced climate change occurs when there is a change with sun's rotational rate. Faster rotation is associated with weak cycles, meaning thereby, that solar input to earth is lower. Conversely a slower rotational speed implies higher influx of solar heat and radiation reaching the atmosphere. For the Aral Sea this means that during the early 1960s the sun's rotational speed was slower, therefore, much more solar input and radiation was able to reach the earth. Some scientists speculate that the recovery of the Aral Sea is expected when the SWGC changes again, which is thought to be at the start of 'Cycle-24' expected to happen in near future. Of course, solar induced climatic change is not confined to the Aral Sea but the sun's magnificent influence affects our entire ecosystem. As the sun goes through its rotational cycles, it is said that it also influences North Atlantic Oscillations, as well as ENSO- El Nino southern oscillations and La Nina affecting sea surface temperature.<sup>12</sup>

#### ***Anthropogenic Causes***

In 1960 the Aral Sea was a large body of water, considered the fourth largest lake in the world, covering an area of about 67, 300 km<sup>2</sup>. During the following century the most complicated and unsustainable irrigation systems were introduced by the Soviets to create a cotton monoculture. A vast array of

dams and reservoirs were designed to redirect the water flowing from the two major rivers leading to major diversions. Drastic increase of river water withdrawal amounting to 75 km<sup>3</sup> /year in recent years, exhausted huge water volumes reducing compensation abilities of the rivers and natural aridity. From 1960 to 1980 92 percent water withdrawals resulted in disequilibrium of water and salt balances. The river water flow into the sea decreased in 1965 upto 30 km<sup>3</sup> /year while during 1971 to 1980 the decrease amounts 60-70 km<sup>3</sup>. During some dry years, runoff of the Amu and Syr Darya reduced to such an alarming level that it actually didn't reach the sea.<sup>13</sup>

As a result, since 1961 the sea water level steadily dropped. The average annual sea level dropping rate was reduced by about 0.5 meters, reaching 0.6 to 0.8 m /year in dry years. During 1990 the sea water surface elevation was 38.24m+BSL, by 2000 about 34m+BSL. Similarly, sea water salinity has increased from 32 percent in 1990 to 40 percent in 2000. Quantitative assessment of anthropogenic factors affecting the water regime of the Aral Sea was carried out for the period 1961 to 1980, according to which more than 70 percent of the sea level lowering salinity increase, was caused by the anthropogenic impact, the rest of these change were implication of the climatic factors (natural aridity).<sup>14</sup>

### ***Glacier-Greenhouse Complexity***

Climate change is expected to exacerbate further water scarcity in the region and aggravate the problems of the Aral Sea Basin. The Pamir Alai glaciers lost 19 percent of their mass during the second half of the 20<sup>th</sup> century. Glacier coverage in various parts of the Tien Shan, Gissaro-Alai, and Pamir mountains, is currently shrinking at the average rate of about 1 percent annually. Observations from the analysis of data for 1968-1998 shows that Abramov Glacier has lost 21metres of its mass (in water equivalent to its 18 percent mass). It is estimated that the glacier would lose an additional 17 percent of its ice by 2020. The melting of glaciers in the headstream water catchments of different rivers would create a situation of water shortage in Central Asia in the long run. The melting of these glaciers has been estimated to ultimately reduce water flow in the Amu Darya and Syr Darya by 40 and 30 percent respectively.<sup>15</sup>

The Central Asian countries have quite different carbon profiles. All the five countries inherited energy-inefficient industrial structures from the Soviet period. Annual green house gas emissions produced by Kazakhstan , Kyrgyzstan and Tajikistan declined sharply in 1990s, due to large declines in industrial production and economic restructuring. However, green house gases increased in Uzbekistan and Turkmenistan . In Turkmenistan this increase exceeded the global average. Rapid growth in its coal, oil and gas industries and its reliance on coal –fired power plants, Kazakhstan has become one of the world's largest green house gas emitters. The per capita green house gas emissions in Kazakhstan, Turkmenistan and Uzbekistan are now well above the global average.<sup>16</sup> Natural gas exploration, gas flaring and aging gas infrastructure in Kazakhstan, Turkmenistan and Uzbekistan result in escaped methane – a highly potent greenhouse gas. The motor transport sector is

significantly releasing the greenhouse gases due to combustion of low quality motor oil. The chief sources of air pollutants are coal burning, inefficient power plants, industry and transportation in the Aral Sea region. Central Asian republics generate large amount of greenhouse gases, mainly carbon dioxide, but significant methane emissions as well as the energy sector, being the largest emitter. During 2004 Kazakhstan released 4196.33 Gg greenhouse gases (GHD). In the year 1994 Uzbekistan released as much as 153,888.0 Gg, followed by Turkmenistan (52,309.5Gg) and Kyrgyzstan (15,051.6 Gg). The annual emissions in Tajikistan in 2008 were 4,284.4 Gg only.<sup>17</sup> Kazakhstan is the 30<sup>th</sup> largest carbon dioxide emitter in the world. Its emissions slowed in 1990s but began to increase again in the 2000s as the country's economy has improved and is expected to double over the next decade. Uzbekistan is the world's most carbon-intensive economy, with greenhouse gas emissions comparable to those of Kazakhstan. More than a quarter (27%) of these gases is methane generated by mining, transport of natural gas, production of oil and coal, and from agriculture-rice cultivation and intestinal fermentation in ruminant livestock. The greenhouse gas emissions grew by 25 percent in the first decade of 2000s. Tajikistan produces little greenhouse gas, relying largely on hydropower for energy needs, offsetting this advantage to some extent, by making carbon dioxide emissions through deforestation. The Kyrgyzstan's emissions fell in the 1990s, nevertheless, its greenhouse gas emissions grew by 25 percent in the first decade of 2000.<sup>18</sup>

Among the most notable environmental changes in the Aral Sea Basin, is that of desertification. As the basin is located in a semi-arid environment where weather is dry and precipitation is low resulting in high evaporation rates. The salt content in Aral Sea Basin is exceedingly high and has penetrated the soil deep. It has become difficult to grow things here and in some areas planting fruit crops and herbal remedies is no longer a viable option. Much of the aquatic life has virtually disappeared.<sup>19</sup> Wind storms are thought to increase in areas experiencing large soil moisture deficits leading to wide spread dust storms. The greatest incidences of dust storms occur when climatic conditions and human pressures combine to make surfaces susceptible to wind attack. Here wind picks particulate matter from the ground and transports the material airborne to other areas of the region. For Aral Sea Basin what becomes airborne are, salt, sand and the toxic chemicals of pesticides used in the agricultural sector. There have also been reports of the release of anthrax, from the central island of Vozrezhdeniye (used as a secret facility for testing biochemical warfare). There is growing concern mounting about surrounding area which may be exposed to the toxins from the island.

### **Impact on Socio-economic Setup**

The phenomenon of climatic change leading to almost an environmental catastrophe in Aral Sea region alongwith other natural as well as human-induced interferences, have influenced negatively on different variable of socio-economy. The areas most affected are Dashoguz region of Turkmenistan, the Kyzyl Orda region of Kazakhstan and the Karakalpakstan region of Uzbekistan. Since the dust storms can blow poisonous salts up to 700 miles away, thereby, affecting

more or less the socio-economic life in the whole Central Asian region.<sup>20</sup> The climate change in Aral Sea Basin has impacted negatively both biotic as well as the abiotic environment of the region. The air, water and soil have been contaminated by the poisonous salts and chemicals blown away by either wind or carried by the water. The important sectors of economy like agriculture, fisheries, manufacturing sector as well as transport and tourism have been negatively influenced by the climate change in the region. The social life of the people has impeded the maximum benefit as the people have lost the livelihood and their health has deteriorated because of the environmental pollution. The impact of climate change can be traced very clearly on agriculture, fisheries, biodiversity and the human health in the region.

### ***Regional Environmental Degradation and Agricultural Sector***

Desert winds move the sand and salt over long distances, delaying millions of tons of salts on the fields throughout the basin, which threatens even the glaciers in mountain ranges that are far from the sea. Every year the sand is lost from dry bottom of the Aral Sea, winds and cyclonic storms which carry 75 million tons of sand as well as 65 million tons of fine dust and salt resulting in lower productivity of pasture and crop yields. Over the years poor irrigation practices have caused millions of hectares to be taken out of production, resulting in direct crop losses across the region equivalent to 1.7 billion dollars annually.<sup>21</sup> On the irrigated lands in the downstream part of Amu and Syr Darya accumulation of about 100 million tons of salt and sand, has caused tremendous damage to the environment, economic and social life in the basin. So far the level suitable for drinking water needs from the ground water is concerned, it reduces by 10-15 meters and then becomes unavailable for public use. The warming leads to the increase in evaporation losses and causes the increase of water demand for irrigation. Under the conditions of water deficiency there is more stress on the limited water resources of the region.<sup>22</sup> It is irony that due to misuse of water, particularly, during Soviet period, some water-surplus areas were converted into to water-deficit ones.

According to Kazakhstan Scientific Research Institute of Environment and Climate, winter wheat crop may fall by more than quarter due to increasing frequency of drought and lower grain productivity. Harvests from natural forage lands may decline by 30 to 90 percent and this along with the direct effect of increased hot weather on animals would seriously affect livestock population.<sup>23</sup> In the past Aral Sea was one of the richest fishing zones in the world. However, in recent years the average annual catch of valuable fish species was 25-27 thousand tons, production of canned fish averaged 18-20 million standard cans. By 1979 shipping was stopped and since 1984 sea fishing completely a lost business. Nearby the Aral Sea, there were 38 species of fishes in the basin and nowadays only 27 species are left.<sup>24</sup> Aral Sea degradation has decimated commerce and killed live stock and fish stocks. Wetland based industries, such as cane-gathering or muskrat breeding, are no longer possible. Feed stock growth has diminished, land can sustain less numbers of livestock, nutritionally this means the reduction in sources of protein for the nearby communities. The overall carrying capacity of dry lands and wet lands has marked a sharp declined trend.

### ***Impact on Human Health***

The aerosolized pesticide and fertilizers that blows in wind, called Aeolian dust by medical scientists, is breathed by inhabitants. It also settles in wells and waterways which later are utilized for drinking and cooking purposes. The incidence of different types of diseases related to environmental hazards, is very high in Aral Sea region. About 97 percent of Karakalpakstan's women were anaemic five times more than other parts of the country in 1987 as per Food and Agricultural Organization Report, manganese and zinc from pesticide ingestion affects human iron uptake. The decrease in women's health affects infant mortality and maternal death rates. In Aral Sea Basin the infant mortality ranges from 70 to 100 per 1000 live births, but in Karakalpakstan such figure worsens recording 100 per 1000 live births – three to four times higher than rest of the CIS countries. The region has high level of maternity deaths (about 120 women per 1000 births). Low birth weight, infections, parasites, growth retardation, delayed puberty and mental retardation are substantially present.

The DNA of Karakalpakstan residents is 3.5 times higher in genetic damage than that of people in the United State. This leads to cancer, a lack of general healing from injury, and birth defects. As in all genetic material, damage can also be passed on to succeeding generations. As per other FAO report, liver cancer rates increased 200 percent between 1981 and 1987. Throat cancer rates rose by 25 percent. Tuberculosis rates have risen 70 percent in the last decade, 30 percent of these cases being multi-drug resistant strains of TB. Among the other illnesses reported from the region are hepatitis and other respiratory complications such as asthma. Because water is often contaminated, there are also high reports of diarrheal diseases and various cancers. In Karakalpakstan (disaster zone) since 1980s there has been 300 percent increase in chronic bronchitis and in kidney and liver diseases, while arthritic diseases have increased 600 percent. In Tajikistan, malaria is on the increase as average air temperatures have slowly been rising over recent decades. In Almaty, and Bishkek, respiratory diseases as a result of environmental pollution are said to affect more than 40 percent of the inhabitants.<sup>25</sup> Anaemia takes a big part in the structure of diseases in the republic of Karakalpakstan which share 50.4 percent of all other diseases. The closer the region to Aral Sea, the higher the level of diseases and death rate are observed . Such conditions do not make this area a favorable choice for habitation, many people are being displaced and forced to migrate out of the region, creating a new phenomena known as 'environmental refugees.'

### ***Loss of Biodiversity***

The natural landscape of the Aral Sea region with its unique tugai flora and fauna of the famous niche-degraded beyond recognition, lost its vitality and attractiveness of natural values. The biodiversity of invertebrates is estimated more than 3500 species but nowadays the areas nearby Aral Sea have lost more than half of the gene pool of fauna and flora. Complicated situation has occurred in the population of Sajjak-Antelope. Nowadays its population is critically endangered. Aral Sea crisis has led to changes in the biodiversity of

Ust Urt plateau. In recent years the region recoded only 35 species of mammals which are listed in the Read Book like gazelle, manul, Indian medoes and caracal types.<sup>26</sup>

The overall direct and indirect socio-economic losses as a result of climate change and consequent environmental disaster in the Aral Sea region, are estimated at 144.83 million dollars. The sector wise losses which are summarised as under, consists of only the immediate neighbourhood of the basin, and in case of whole basin the figure may cross a loss of billions of dollars.<sup>27</sup>

<b>Subsector</b>	<b>Loss(million dollars)</b>
Irrigation Farming	6.55
Fisheries and Fish Breeding	28.57
Muskrat Hunting	4
Cattle Breeding	8.4
Recreation and Tourism	11.16
Fish Industry	9
Muskrat Pelt Processing	18
Cane Processing	12.6
Transportation	1
Indirect Losses	16.74
Social Losses	28.81

For the Central Asian countries, especially those dominated by deserts like Kazakhstan, Turkmenistan and Uzbekistan, adaptation to climate change will have to adopt a set of measures. In agriculture, it will require combating drought and desertification using crops that need less water or have a growing season suited to changing conditions, using advanced methods of fertilization and pest control and managing pasturelands with improved technology to prevent overgrazing and to rehabilitate degraded pastureland. For water resource adaptation, measures include minimizing water losses in irrigation and transport canals, more efficient irrigated farming, improving sanitary and industrial practices near open water and ground water sources, and better protection of water sheds from degradation and contamination. Since the environmental degradation and consequences, thereupon, are routed in natural as well as man-induced causes, the intensity can be minimised, particularly, with respect to latter variable, by managing water and land resources properly with a focus also on inter-generational responsibility i.e. regional sustainable development.

## **References & Notes**

- 1 Inter State Water Commission of Central Asia: "Aral Sean Basin – Location, Geomorphology and Landscape," *Cawater Info.*, <http://www.cawater-info.net/arak/geo.htm>, last retrieved on 20/1/2012.
- 2 Ibid, p. 2.
- 3 Ibid.
- 4 Inter State Water Commission of Central Asia: "Water Resources of the Aral Sea Basin," *Cawater info.*, [http://www.Cawater-info.net/arak/water\\_e.htm](http://www.Cawater-info.net/arak/water_e.htm), last retrieved on 20/1/2012.
- 5 Ibid, p. 2.

- 6 Ibid, pp. 2-3.
- 7 Kezber, Martine (2011): "Life Without Water – The Aral Sea Basin," *Changing Planet*, [http://www.changing-planet.org/2011/O8/17/life without water the aral sea basin](http://www.changing-planet.org/2011/O8/17/life-without-water-the-aral-sea-basin), last retrieval on 09/02/2012.
- 8 Ibid, p. 5.
- 9 Op.cit., 4.
- 10 Kulmatov, R. and Soliev, I. (2008): "The Crisis of Aral Sea and Health of the Population in the Disaster Zone," National University of Uzbekistan.
- 11 Inter State Water Commission of Central Asia: "Bathymetric Characteristics of Aral Sea," *Project INIAS-0511 REBASOWS*, [http://www.cawater-info.net/aral/water\\_e.htm](http://www.cawater-info.net/aral/water_e.htm).
- 12 Op.cit., 7.
- 13 Inter State Water Commission of Central Asia: "Degradation of the Aral Sea and South Prearalie," *Cawater Info.*, [http://www.cawater-info.net/aral/water\\_e.htm](http://www.cawater-info.net/aral/water_e.htm), last retrieved on 20/01/2012.
- 14 Ibid, p. 3.
- 15 United Nations Development Programme (2008): "Climate Change in Central Asia," *Development and Transition*, [http://www.developmentandtransition.Net/Article35+MS400-32408 a.o.html](http://www.developmentandtransition.Net/Article35+MS400-32408_a.o.html), last retrieved on 21/02/2012.
- 16 Asian Development Bank (2010): *Central Asian Atlas of Natural Resources*, Manila, Philippines, 160-61.
- 17 Ibid, p. 159.
- 18 Ibid, p. 161.
- 19 Kezber, Martine (2011): *Life Without Water – The Aral Sea Basin*, 8.
- 20 Foreign Policy Association (2007): "The Aral Sea Disaster – Living the Climate Change Prophecy," <http://foreignpolicyblogs.com/2007/04/11the-aral-seadisaster-part-3>, *living the climate-change-prophecy*, last retrieved on 21/02/2012.
- 21 Op.cit., 16, p. 152.
- 22 United Nations Development Programme (2008): "Water – Vital Resource for the Future of Uzbekistan," *Proceedings*, International Conference, 11-12 March, Tashkent, 127.
- 23 Op.cit., 16, p. 161.
- 24 Government of Republic of Uzbekistan (2008): "Second National Communication Under the United Nations Framework," *Convention on Climate Change*, Tashkent, 187.
- 25 Op.cit., 16, p. 159.
- 26 Kulmatov, R. and Soliev, I. (2000): *The Crisis of Aral Sea and Health of the Population in Disaster Zone*, 9.
- 27 Inter State Water Commission of Central Asia: "Climate Change Problems in Aral Sea Basin (Example of Uzbekistan)," *Third Aral Sea Basin Programme: A Regional Action Plan 2011-2015*, 5.

