# Climatic changes of the past and its impact on the biological diversity in Sindh, Pakistan.

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# Climatic changes of the past and its impact on the biological diversity in Sindh, Pakistan.

The scientific studies helps to understand the impact of climatic changes like greenhouse gases effect and global warming on biological diversity of species in the past and how they resulted into improvement of the genetic resources of crop, plants and their wild relatives upon which human survival depends.

**Introduction.**

The last Ice age, which ended 15,000 years ago and it started warming. The deciduous trees at the foot of the hill move up the hills and were replace by Savannahs. As it warm more trees started moving up-hill in search of colder weather. Today we have the following wild plants on the top-of the hills in Dadu and Larkana Districts at height of 3500-7000 feet. The plants observed these are:

- Wild apple.
- Wild peach.
- Wild plum.
- Wild grapes.
- Wild almond.

The detailed survey has not been done by professional botanist to find out deciduous shrubs, wild plants, grasses and etc.

On the Savannahs came wild animals like Zebu cattle (Bos Indicus), wild sheep (ovis), wild goat (caprahircus), ibex, deer and many other animals and their predators followed by man the leading predator of all of them.

Man then lived by praying animals, gathering wild fruits, vegetables, tubers, roots etc. By around 9,500 years ago he was able to domesticate wild animals like cattle (cows and buffaloes), wild sheep and goat. He started cultivating wild grasses likes wheat and barley around 9,000 years ago. He also was gathering wild fruits like zizyphus, rountiflora, date palm, almost simultaneously and grapes. These three crops were domesticated around latest 8,000 years ago. His dress consist of leather, soon around 6,000 years ago he was able to weave cotton for clothing and which started replacing leather. About 9,000 years ago human start cultivation of crops. At the 9,000 years ago he had already started building houses with mud bricks and thatched roof consisting of wooden beam, rafters and thatched grasses. The leather still was used for baskets, cushions, water storage, containers, bed-mattresses and covers. Some tents of leather were used before building mud houses. The domestication of crops was in the following order:

- Millet and sorghum of Africa reached Arabia and were domesticated there in 4,500 BC.
- It reached eastern coast of Arabia in 3,000 BC and in Sindh possibly by 2,350-2,000 BC i.e., start of Mohen-jo Daro.
- South Western Quadrant of Asia consisting of Armenia, Iraq, Syria, Jordan, Southern Turkey, Afghanistan and Baluchistan have been core centuries of most upland cereals and grasses.
- Rajdi in Saurashtra after 2,000 BC wheat and barley disappear and were replaced by Millets namely (Eleusine, coracana, sorghum and Panicum setaria, summer crop, possibly due to lack of winter rains).

 

## Fauna of Sindh.

### Early Holocene 12,000 - 9,000 years ago.

Post Ice Age development in Sindh its effect of warming was that deciduous trees, which grew at the foot of hills, moved up the hills to 3000-5000 feet elevation and were replaced by savannah or grasslands, which became hosts to many animals like:

- Wild sheep.
- Wild goat.
- Bos (cattle).
- Deer.
- Ibex.
- Urial
- Hare.
- Porcupine.
- Nilgai.
- Hogdeer (Pharaha).
- Pig.

In Sindh cattle was first domesticated and then sheep and goat. This is now called adoption of Mesolithic way of life and its beginning in Sindh goes back to 9,500 years ago.

Their predators like:

- Lion.
- Tiger.
- Panther.
- Wolf.
- Jackal.
- Hyena.
- Fox.
- Wild cat.
- Badger.
- Leopard.
- Redlynx.
- Pangolins.
- Black bear.

 

Table below gives the pattern of diversity in crops from 7000 B.C to 800 B.C in Sindh.Pakistan.

| Name of plant | 7000-6000 BC IA | 6000-5000 BC IB | 5000-4500 BC II | 4500-3800 BC III | 3800-3400 BC IV | 3400-3100 BC V | 3100-2800 BC VI | 2800-2500 Bronze Age VII | 2500-2000 BC Harap-pa | 2000-1300 BC Jhukar | 1300-900 BC Jhangr |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Spring-harvested crops** | | | | | | | | | | | |
| Triticum sp (wheat) | + | + | + | | | | | | | | |
| Timonoccum (cinkorn) | + | + | + | | | | | | | | |
| T.cf.durum (hard wheat) | + | + | + | | | | | | | | |
| T.dicoccum (emmer) | + | + | + | + | + | | | | | | |
| T.aestivum/compactum(bread/club wheat). | | + | + | + | + | + | + | + | + | + | + |
| T.sphaeroccum (shot wheat). | | | + | + | + | + | + | + | + | + | + |
| **Hordeum sp (barleys)** | | | | | | | | | | | |
| H.spontancum (2-raw wild barley). | + | + | | | | | | | | | |
| H.distichum (2-row hulled barley). | + | + | | | | | | | | | |
| H.vulgare var. mudum (6-row naked barley). | + | + | + | + | + | + | + | + | + | + | + |
| H.sphaeroccum (6-row naked short barley). | + | + | + | + | + | + | + | + | + | + | + |
| H.vulgare (6-row hulled barley). | | | | + | + | + | + | + | + | + | + |
| Avena sp (Oat) | | | | | | + | | + | | | + |
| Pisum sativum var. arvense (field pea). | | | | | | | | | + | | |
| Zizyphus mauritiana or zizyphus nummularia. | | | | | | | | | | | |
| Zizyphus jujube (jujube). | + | + | + | + | + | + | + | + | ? | ? | + |
| Brassica Juncca (brown mustard). | | | | | | | | | ? | | |
| Linum usitatissium (Flax/linseed). | | | | | | | | | | | + |
| **Generally fall-harvested crops.** | | | | | | | | | | | |
| Phoenix dactylifera (date). | + | + | + | | | | | | | ? | |
| Goosypium sp (cotton). | | | | + | | | | | | | |
| Vitis Vinifera (grape). | | | | | | + | | + | + | | + |
| Sorghum bicolar and Sorghum vulgare. | | | | | | | | | ? | + | + |
| Sorghum sp (sorghum). | | | | | | | | | ? | + | + |
| Oryza Sativa (rice). | | | | | | | | | ? | | + |
| Seasum (seasmum indicum). | + | + | + | | | | | | | | Before 1000BC |
| Sugar cane. | | | | | | | | | ? | + | + |
| Millet (setaria sp). | | | | | | | | | | | + |
| Setaria italica. | | | | | | | | | | | |
| Setaria virids. | | | | | | | | | + | + | + |
| Setaria verticilla. | | | | | | | | | | | + |
| Setaria glauca. | | | | | | | | | | | + |

 

| Name of plant | 7000-6000 BC IA | 6000-5000 BC IB | 5000-4500 BC II | 4500-3800 BC III | 3800-3400 BC IV | 3400-3100 BC V | 3100-2800 BC VI | 2800-2500 Bronze Age VII | 2500-2000 BC Harap-pa | 2000-1300 BC Jhukar | 1300-900 BC Jhangr |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vigna (cow pea vigna catjang) Vigna (cow pea vigna sinensis) | | | | | | | | | + | | |
| Chenopodium album. | | | | | | | | | | | + |
| **Edible wild plants like:** Euphoribia. Brachiara. Andropogon. | | | | | | | | | + | + | + |

Medicinal plants of Indus Culture Times

| Name of plant | | 7000-6000 BC IA | 6000-5000 BC IB | 5000-4500 BC II | 4500-3800 BC III | 3800-3400 BC IV | 3400-3100 BC V | 3100-2800 BC VI | 2800-2500 Bronze Age VII | 2500-2000 BC Harap-pa | 2000-1300 BC Jhukar | 1300-900 BC Jhangr |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scientific Name | Family Name | | | | | | | | | | | |
| Abelmoschus | Malvacae | | | | | | | + | + | + | + | + |
| Acacia | Mimosoideae | | | | | | | + | + | + | + | + |
| Boerhavia | Nyctagina-eae | | | | | | | + | + | + | + | + |
| Borreria | Compositae | | | | | | | + | + | + | + | + |
| Convolvulus | Convolvulaceae | | | | | | | + | + | + | + | + |
| Carchorus | Sterculiaeae | | | | | | | + | + | + | + | + |
| Cucumis | Cucurbi-taceae | | | | | | | + | + | + | + | + |
| Cymbopogon | Poaceae or Gramineae | | | | | | | + | + | + | + | + |
| Cyperus | Cyperaceae | | | | | | | + | + | + | + | + |
| Digera | Amaran-taceae | | | | | | | + | + | + | + | + |
| Dious | Urticaceae | | | | | | | + | + | + | + | + |
| Glossocardia | Compositae | | | | | | | + | + | + | + | + |
| Goniogyna | Papilionaceae | | | | | | | + | + | + | + | + |
| Indigofera | Papilionaceae | | | | | | | + | + | + | + | + |
| Ipomoea | Convolvu-laceae | | | | | | | + | + | + | + | + |
| Lens | Fabaceae or Leguminosae | | | | | | | + | + | + | + | + |
| Melochia | Sterculiaceae | | | | | | | + | + | + | + | + |
| Paspalum | Poaceae or Gramineae | | | | | | | + | + | + | + | + |
| Phyllanthus | Euphorbia-cidae | | | | | | | + | + | + | + | + |
| Polygala | Polygalaceae | | | | | | | + | + | + | + | + |
| Polygonum | Polygonaceae | | | | | | | + | + | + | + | + |
| Rorippa | Cruciferae | | | | | | | + | + | + | + | + |
| Sida | Malvastrum | | | | | | | + | + | + | + | + |

 

| Name of plant | | 7000-6000 BC IA | 6000-5000 BC IB | 5000-4500 BC II | 4500-3800 BC III | 3800-3400 BC IV | 3400-3100 BC V | 3100-2800 BC VI | 2800-2500 Bronze Age VII | 2500-2000 BC Harap-pa | 2000-1300 BC Jhukar | 1300-900 BC Jhangr |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stellaria | Caryophyl-laceae | | | | | | | + | + | + | + | + |
| Tragus | Poaceae or Gramineae | | | | | | | + | + | + | + | + |
| Trianthema | Aizoaceae | | | | | | | + | + | + | + | + |
| Zizyphus | Rhamnaceae | | | | | | | + | + | + | + | + |

Table below shows the crops cultivation from 7000 - 900 BC.

| Year | Crops cultivated during this times |
|---|---|
| Mehrgarh 7,000 BC I | Wheat, barley, jujube, date and seasum. |
| 6,000-5,500 BC II | Wheat, barley, jujube, date and seasum. |
| 4,000-3,800 BC III | Wheat, barley, jujube and (cotton new crop). |
| 3,800-3,400 BC IV | Wheat, barley, jujube. |
| 3400-3100 BC V | Wheat, barley, (Oat new crop), jujube, and (new crop grapes). |
| Bronze Age 2,800 BC VII | Wheat, barley, oat, jujube and (new crop sorghum). |
| Harappan 2500-2000 BC | Wheat, barley, (new crop field pea), (new crop chick pea), grapes, (new crop rice), (new crop cow pea), (new crop edible wild plants). |
| Jhukar Pirak 2000-1300 BC. | Wheat, barley, jujube, sorghum, millet rice (at Pirak). |
| Jhangar 1300-900 BC. | Wheat, barley, oat, jujube, cheek pea, (new crop flax/linseed), grapes, sorghum, rice, millet and (new crop chenopodium album). |

**Detail of the chart.**

- Chart above shows the corps which were domesticated from the wild over 6,000 years i.e., 6000 - 900 BC during this period rainfall and temperatures varied making possible domestication of some crops. These crops existed in wild and man had to select depending upon their uses and amount of need for it. They domesticated certain types of wheat and barley but soon found better varieties either from wild or natural mutation taking place within species. The table shows that some plants like Triticum monoecum (cinkorn) and Triticum ef durum were cultivated from 6,000 to 5,500 BC but soon disappeared from 4000 to 3800 BC soon a new variety of wheat Triticum dicoccum were introduced in 3400 BC. Again this variety disappeared in 3,400 BC. From 6,000 BC two new wheat varieties, Triticum aestivum/Compactum and Triticum sphaeroccum appeared and continued to be cultivated even after fall of Indus civilisation in 2,000 BC were still cultivated 900 BC.
- The 2 row barley varieties Hardeum spon tancum and Hordeum distichum were cultivated in 7000-6000 BC, but disappear in 5,500 BC. Simultaneously two 6 rows barley varieties Hordeum-vulgare and Hordeum sphaeroccum were cultivated from 7,000-900 BC.
- Avena sp (oat) was cultivated in 3400 BC and 2,800 BC and 900 BC although during 3100-2,800 BC and again in 2,000 BC no data of oat cultivation is reported.

 

- Pisum sativum var arvense (field peas) were only cultivated in 2500-2000 BC.
- The most common fruit of past and now, zizyphus mauritiana or zizyphus nummularia-normally called (jujube) were cultivated from 6,000 BC and continued to be cultivated even after the Indus civilisation in 1300 BC. They were still cultivated up to 900 BC and are cultivated even now. Being drought and salinity resistant they survived during arid climate but their yield decreases and is very high under irrigation and non saline soils.
- Brassica Juncca (brown mustard) was cultivated in 2500-2000 BC although sufficient data is not available.
- Linum usitatissum (Flax/linseeds) were only start cultivation in 900 BC.
- Phoenix dactylifera (date) were cultivated from 6,000-5,500 BC. It is common plant of Sindh although due to limited excavation it is now shown after 5,500 BC to 2,500 BC. After Indus civilisation in 1300BC its new varieties appears and start cultivation upto 900 BC period.
- Gossypium sp (cotton) was cultivated in 4,000-3,800 BC period. Some archaeologists have doubts about cotton and think it was flax.
- Vitis Vinifera (grapes) its cultivation is reported in 3400-3100 BC, 2500-2000 BC and 900 BC while from 3100-2800 BC and 1300 BC there is no prove of its cultivation is reported.
- Sorghum bicolor and sorghum vulgare (sorghum) start cultivation during Indus civilisation in 1300 BC and remained cultivated till 900 BC period.
- Its presence in Mehrgarh is shown around 2,800-2,500 BC and therefore it may have been present in Indus Civilisation times.
- Oryza Sativa (rice) only start cultivation in 1300-900 BC.
- Seasum (Sesamum indicum) was cultivated from 6,000-5,500 BC, but its archaeological presence in not shown after 5,500 BC.
- Sugarcane was cultivated in 1300-900 BC.

| | | |
|---|---|---|
| Sctaria italica.<br>Sctaria Virids.<br>Sctaria verticilla<br>Sctaria glauca. | | Millet species were start cultivation around 1300 BC. It was present at Mehrgarh around 2500-2000 BC. |
| Vigna catjang<br>Vigna sinensis | cow pea | Were cultivated in 2500-2000 BC and possibly continued up to 20$^{th}$ century. |

- Dolichos biforus (Horse gram) was cultivated in 1300 BC and is since continued.
- Edible wild plants like: Euphorbia, Brachiara and Andropogon were cultivated in 2500-2000 BC.

The important medicinal plants of Indus Culture Time were cultivated from 3100-900 BC. These plants are: Albelmoschus, Acacia, Boerhavia, Borreria, Convolvulus, Corchorus, Cucumis, Cymbopogon, cyperus, Digera, Dious, Glossocardia, Coniogyna, Indigofera, Iponoea, Lens, Melochia, Paspalum, Phyllanthus, Polygala, Polygonum, Rorippa, Sida, Stellaria, Tragus, Trianthema and Zizyphus.

 

**Table below gives percent of rainfall, temperature, cropping patterns and effects of climate on society, political, social and Economic from 7000 BC to 500 BC in Sindh-Pakistan.**

| Time Period years BC | Times Present Rainfall | Tempera-ture Compared to 1975 °C | Cropping pattern | Effects on society, political, social and economic |
|---|---|---|---|---|
| 9,000 | 1.75 | +1.99 | Wheat, barley, jujube, date and seasum. added. | Wheel turned pottery, better housing. Neolithic revolution at Mehrgarh. |
| 8,000 | 2.2 | +2.14 | Domestication of food crops started. | Further improvement at Mehrgarh. |
| 7,500 | 2.00 | +2.14 | Cotton introduced. | Sea level rose rapidly. |
| 6,000 | 1.4 | 0.01 | Cotton introduced. | Drought, Gabarbands in Kohistan and man moves to Indus plain at Amri. |
| 5,000 | 1.7 | +0.99 | Two new types of wheat. Two new types of barley (6 row), grapes and oats.(new crops ) | Kot Dijjji development over Amrian base. |
| 4,500 | 2.6 | +1.70 | Two new types of wheat. Two new types of barley (6 row), grapes and oats.(new crops ) | Mature Indus Civilization at Harappa and Mohenjo Daro. Microlithic tools for hunting, harvesting, domestic use. |
| 4,000 - 3650 | Half and less | Low presently -0.5 to 1.0 | Wheat, and barley, reduce, dates, Sorghum, millets and rice. | Down fall of Indus Civilisation start.. |
| 3,500 | - | - | Wheat, and barley, reduce, date, sorghum ,millets ,rice (oat-new crop). | It started cooling and cold period with low rainfall continued up to 2,500- years ago. In Sindh it was cold from 2,000-500 BC and therefore dry. Pastoral economy, desertification. |
| 3,000 | - | - | (Medicinal plants - new crop). | Pastoral economy and desertification. |
| 2,500 | - | - | Wheat, barley, jujube, sorghum. Medicinal plants. New crops introduced are:<br>▪ Field pea.<br>▪ Chick pea.<br>▪ Cow pea.<br>▪ Rice.<br>▪ Edible wild plants. | Warm period only for couple of centuries and then medium cold from 300 BC to 400 AD. Achaemenian and Alexnader's conquest of Pakistan followed by Bactrian Greeks, and Scythians upto 2,000 BC was 3 meter higher than today. |

 

| Time Period years BC | Times Present Rainfall | Tempera-ture Compared to 1975 °C | Cropping pattern | Effects on society, political, social and economic |
|---|---|---|---|---|
| 1,500 | Arid | +1.09 | Wheat, barley, oat, jujube, chick pea, grapes, sorghum, rice, millet. Medicinal plants. | Warm period and therefore more rainfall from 400 to 650 AD and then cold upto 900 AD. From 900-1200 AD it was warm with more rainfall, Vahlika. |
| 1,000 | Arid | +0.59 | New crop introduced are:<br>▪ Flax/linseed.<br>▪ Chenopodium Album. | Rai Dynasty Brahman and Arab conquest. Habaris and Soomras. |
| 800 | Arid | -0.81 | | This is the period 1200-1500 AD, which was moderately cold, but worst was from 500-1850 AD in Sindh known as Little Ice Age. End of climatic optimum. |
| 500 | Arid | -0.01 | | Little Ice Age and civil war in Sindh with Arghoons, Tarkhans and Mughals. Decay of the Indus or Harappan Civilisation (Jhukar and Jhangar). |

Source: National Research Council, 1975, p. 130.

**General Description.**

- Like today the climate in Sindh was not constant, in the past some time it warm-up and other time enter to Ice age. These climatic changes brought lot of changes in cropping pattern of this region, which discussed here.
- When increase carbon dioxide ($CO_2$), Methane gas ($CH_4$), Nitrous oxide ($N_2O$), Chlorofluoro carbons CFC's it effect on climate:
  - Temperature.
  - Precipitation.
  - Water vapour.
  - Winds.
  - Radiation field.
- This increase water stress on agricultural crops.
- Change in soil temperature and moisture shows significant effect on organic matter content and the availability of nutrients like nitrogen and phosphorus.

 

- When carbon dioxide (CO2) increase in atmosphere, it increases soil temperature and decrease moisture will increase soil carbon turnover this will increase nitrogen availability.
- Drought produce direct effect on abscisic acid level in plants, this play a central role in causing the adaptive response to plant stress.
- 1°C increase in temperature result into increase the rate of respiration by 10-30% show little effect on photosynthesis so they stimulate the release of carbon dioxide and methane, adding to the greenhouse effect.
- By changing climate the plant leaf pore (stomata) size, opening, dryness change with temperature so decrease in stomata resistance to evaporation as temperature rise and plant rate of transpiration disturb. In warm weather, water stress on plant results into increase temperature and decrease the amount of water reaching the soil. Increase CO2 in the atmosphere show direct effect to decrease transpiration and therefore produce water stress on the plant.
- Other cropping systems that increase the flexibility of response to drought and management practices like water harvesting and field-level storage was an alternative to the older crops.
- Millet (Setaria spp) need low rainfall 50-75 centimetres or irrigation or can be grown as sailabi cultivation on limited rainfall.
- Once the events causing food stress subside, as when moisture patterns returns to more usual and predictable cycle, the subsistence system reverts to a many reliance on millets.
- Climatic change play a direct effect on soil structure, soil nutrient, soil erosion, pest and diseases.
- Sorghum and millet can tolerate drier and hotter conditions than barley and wheat.
- Sesame need warm climate but it cannot withstand frost and continued heavy rain.
- Barley have little or no gluten is inferior as compared to wheat. But it tolerant of alkalinity, frost, drought needs little nutrients to grow.
- Rice need rainfall below 200 like water logged conditions.
- The rainfall and yearly temperature effect on the growth of winter grasses like wheat and barley, while in summer have monsoon rain so summer grasses like millet grow well.
- Wheat needs annual precipitation or irrigation 37-110 centimetres, a little wheat is grown in region with less than 22.5 centimetres of rainfall. Triticum sphaerococcum is highly resistant to drought. It needs cool climate at the time of sowing sufficient warmth with high humidity at the time of grain formation.
- At 7,000 BC Mehrgarh the agriculture was dominated by naked six-row barley, while at ceramic Neolithic the naked (bread and shot) wheat also appeared. This based on kind of irrigation was used at that time. At the same time we get an evidence of wheat, barley, edible-plant foods, jujube, cotton and date, which are harvested in late summer and require moisture for its growth.
- At 7,000-6,000 BC Mehrgarh they found cultivated naked-six-row barley, hulled six row barley, einkorn wheat, domesticated emmer wheat and durum wheat, all these crops only grown in winter months.
- As early 7th millennium BC 6,000-5,000 BC the wild form of plants from the foundation for agricultural development in the region.
- At 5,500 BC Neolithic time find the remains of two arboreal forms of jujube and date, the fruit of which are harvested in the winter and summer, respectively.
- 
- Winter crops of wheat and barley became insufficient by the end of the third 2,500-2,000 millennium BC 2,500-2,000 BC in Harappan Culture. A shift to multi-cropping, with the addition of summer cultivation using borrowed species like millets and sorghum helped the existing population survive enable them to exploit new environments.
- In 1300 BC, various legumes wheat, barley, sorghum and millet and grapes were also grown.
- At the end of Harappan period in the 1300-900 BC early 2nd millennium BC the pastoral peoples in the Greater Indus valley grow only two winter/spring-grown cereals (wheat and barley).

 

- The beginning 1300-900 of 2nd millennium BC a great diversification of agriculture started by the introduction of rice, millet, sorghum, rice which required more water.
- 727-821 BC a significant decrease in the cultivated species like: wheat and barley along with an increase in wild species like Indian jujube between 1,600 - 700 BC. This bring chronic food stress, on that area.

**Field observations.**

The alluvial basin of the Indus River, the area as a whole is semi-arid to arid, having subtropical climate, rainfall averaging less than 200 mm/year. The natural vegetation reflect both climate and topography.

Whenever new plants and animal added in food, this diversification is used to identify food stress time. The new variety of plants developed under drought conditions, at different seasons and in different soil as a results new varieties of plants developed.

Certain plants and food item which probably considered a less desirable or low preference food has been used as a replacement for the more common domesticates, this is an indicator of food stress. Low-preference food are those people eat but usually avoid in time of normal food availability. These species are usually wild Taxa.

Even in the past people are using balance plantation consist of plant origin diet:

- Carbohydrate derived from cereals like wheat, barley, millet.
- Protein from peas, chick pea, vigna and horsegram.
- Fat from seeds of sesame and mustoral.
- Also fruits like: jujube, date.

Food shortages and thus food stress may be the result of natural phenomena such as shifts in climatic conditions, insect infestation, flooding, and disease or cultural phenomena such as socio-political disturbance, welfare, administrative difficulties and migration.

**Conclusion.**

- All the plants growth depend upon soil (type, pH), water availability, temperature, wind, sun-shine hours, chill-units moisture in the environment, cold and warm season. Any one of above factor change than the plant ecology also change and it show direct effect on the plant activities like in hot weather the plant mature earlier than winter months but its nutritional level is also affected example wheat and rice crops.
- The crops usually grown in arid area, under drought condition due to more sun-shine many fruit crops develop sugar level much higher than the normal condition like mangoes, guava, sapodilla.
- The crop grows under harsh condition change their physiology to meet their own condition like some plant develop spine to reduce leafy portion example jujube and bougainvillaea.
- The other crops change their habit according to new soil condition like the plant grown in a soil which is different in nitrogen so the plant grown here produce a flower which attracted by insect so the flower caught them and digest these insect to full fill nitrogen deficiency.

 

- But now a day science is too advanced with the help of new scientific tools like genetic engineering, molecular biology and new methods of propagation are used to developed plant with desired characteristic, with more nutritional value, can be grown under various life. More production, dwarf varieties with resistant to infection and diseases. So this make us able to feed the growing population.
- In the past such condition and technologies were not there with any environmental disaster wipe-off the large number of population based on these crops food. It is possible in the past history the climate must be suitable to certain crops so that why ancient people were very advance in Mohen-jo Daro and Jam Nazimuddin graveyard at Makli hills. All these archaeological sites show the in the past people food must contain a balance diet so their brain developed extra ordinary intelligence.
- If we know the nutritional pattern of the past population. We can trace out the history of that area. Because human health based on food, if we will be able to trace out the total ingredient of their food, we can check their health, height, attack of infection and diseases, bone structure make-up and many other relevant information.

**Future work.**

- Future work is needed conservation of germplasm of olden wild varieties of crop used in the past. Breeder needed to develop new cultivar using old gene, cross breed with latest varieties and evolve unique cultivar.
- More work is needed to trace out the history of Sindh on the basis of Flora and nutrition of the past population.
- Wild rice varieties posses genes of considerable economic importance, and local varieties have been lost due to the cultivation of new varieties. More research is needed to study a male sterility gene used to assist in the production of hybrid rice varieties came originally from their wild relatives. These hybrid varieties yield up to 30% more than ordinary varieties.
- We need to identify vulnerable regions and analyse yield climate relationship, effect of climatic variation on yield and change in yield.
- Comparative analysis of flora required for old and new cultivar crops identified archaeologically.
- More research is needed to study the collection, conservation, regeneration and uses of past crops plant genetic resource and used for breeding of new plants varieties as well as use to study to trace out the nutritional pattern of past history. This study will help for future agricultural planning and food supply.
- Bio-scientist need to study the ecological effect of climatic change on vegetation and plant population of the past and draw a line for future prediction.
- We need to study the past environmental problems, environmental ecology, pollution and threats to evolution of gene culture and draw a better strategies to phase-out these environmental risk in future.

 

# Climatic changes of the past and its impact on the biological diversity in Sindh-Pakistan.

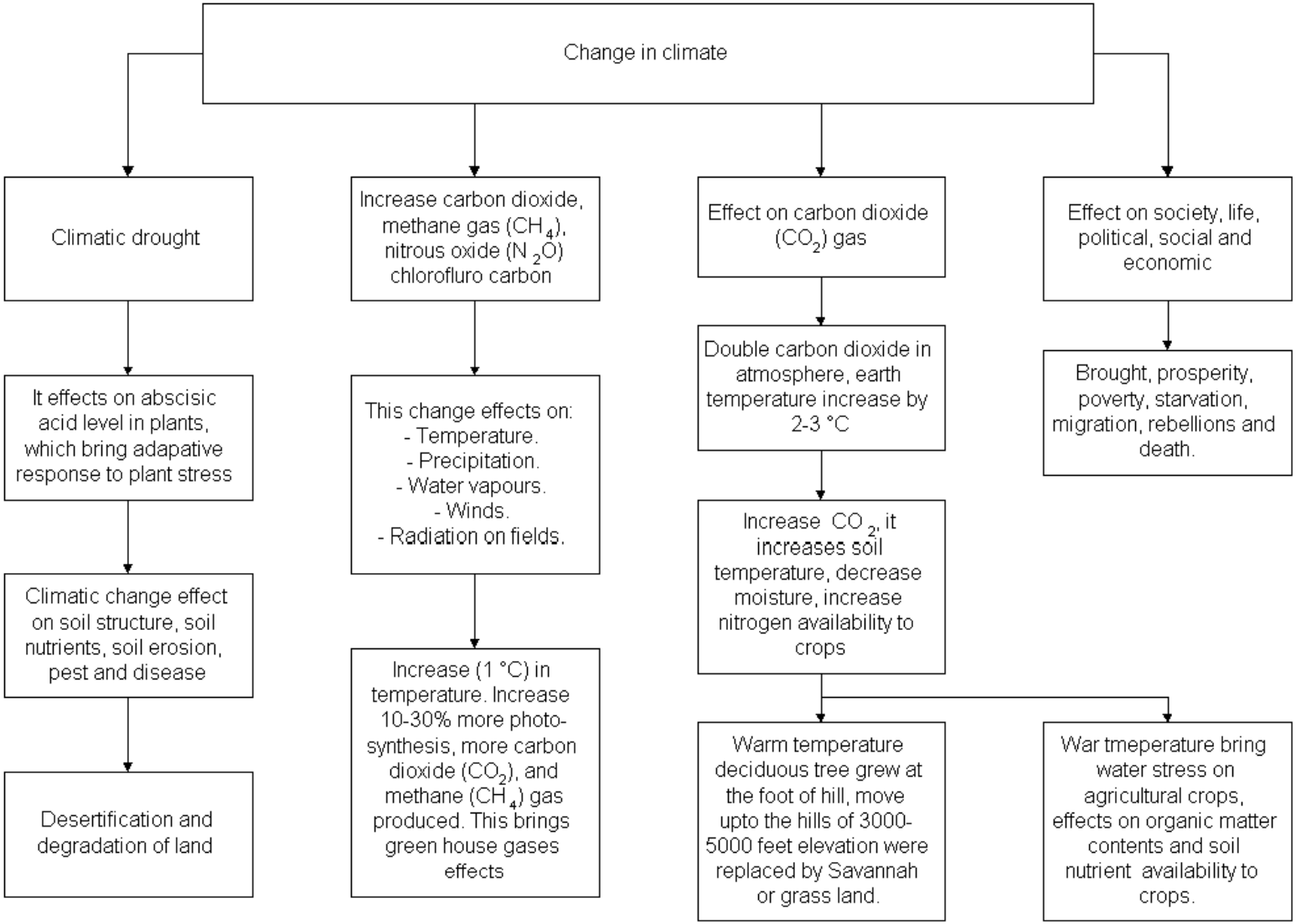


Figure: Designed by Farzana Panhwar

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