

Land Subsidence & Earth Fissures Caused By Groundwater Exploitation In Quetta Valley, Pakistan

By:

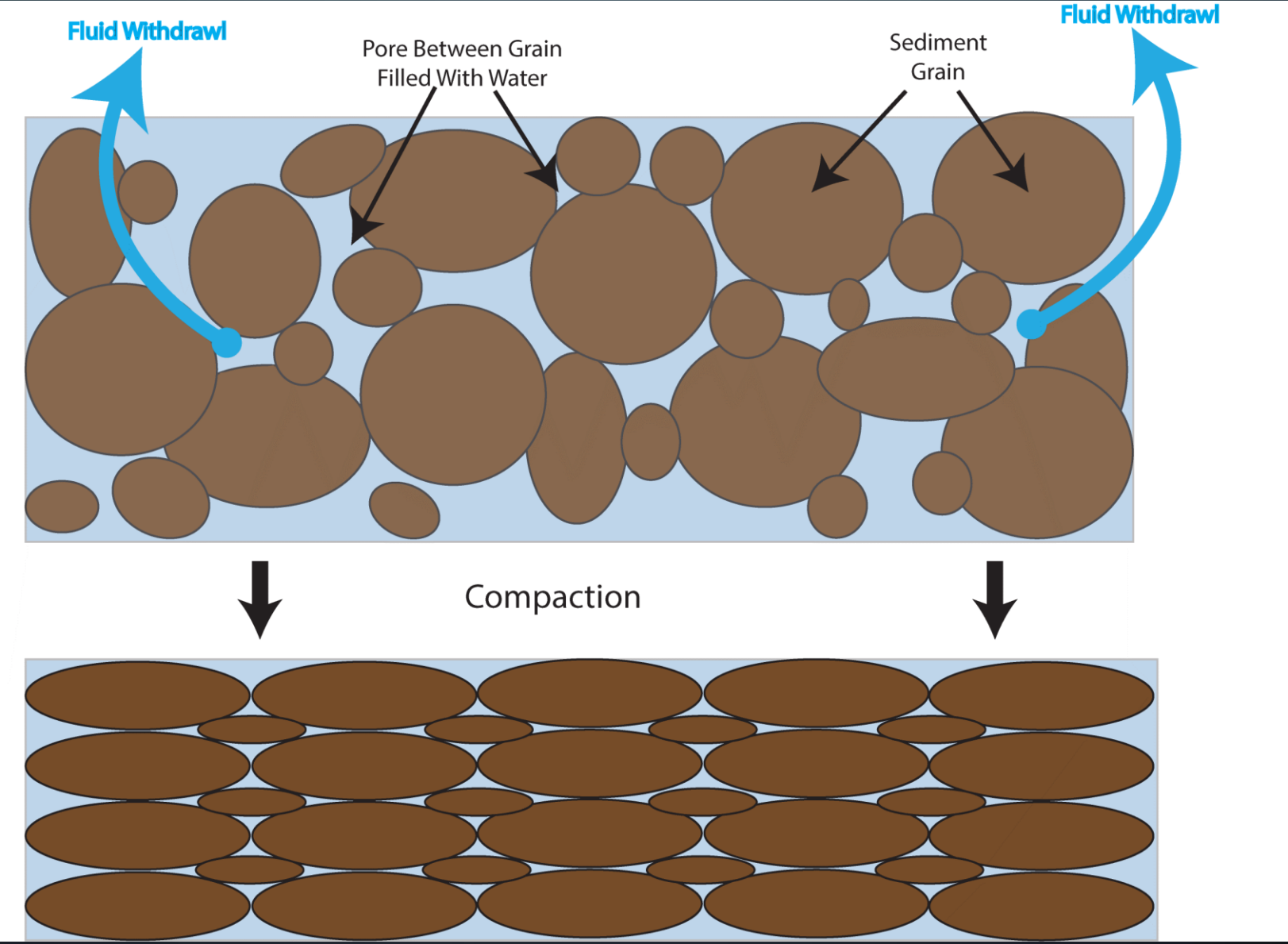
Najeebullah

Objectives Of The Research:

- To evaluate the ground water depletion in Quetta valley.
- To identify land subsidence in Quetta valley and predict the damages that will be inflicted upon the infrastructure.
- To find out the causes of groundwater depletion and land subsidence in the region.
- To quantify the land cover and land use changes over time.

What is Land subsidence?

- Land subsidence is the slow sinking of an area caused by natural and anthropogenic phenomenon.
- In a natural aquifer system an equilibrium is established that is, the amount of water recharge is equal to the amount of water discharge.
- When this equilibrium is disturbed land subsidence occurs.
- Quetta valley aquifer is an unconsolidated alluvium consisting of fine grained particles that are highly compressible.
- When the water molecules from the voids are extracted the voids collapses and the land become subsided.



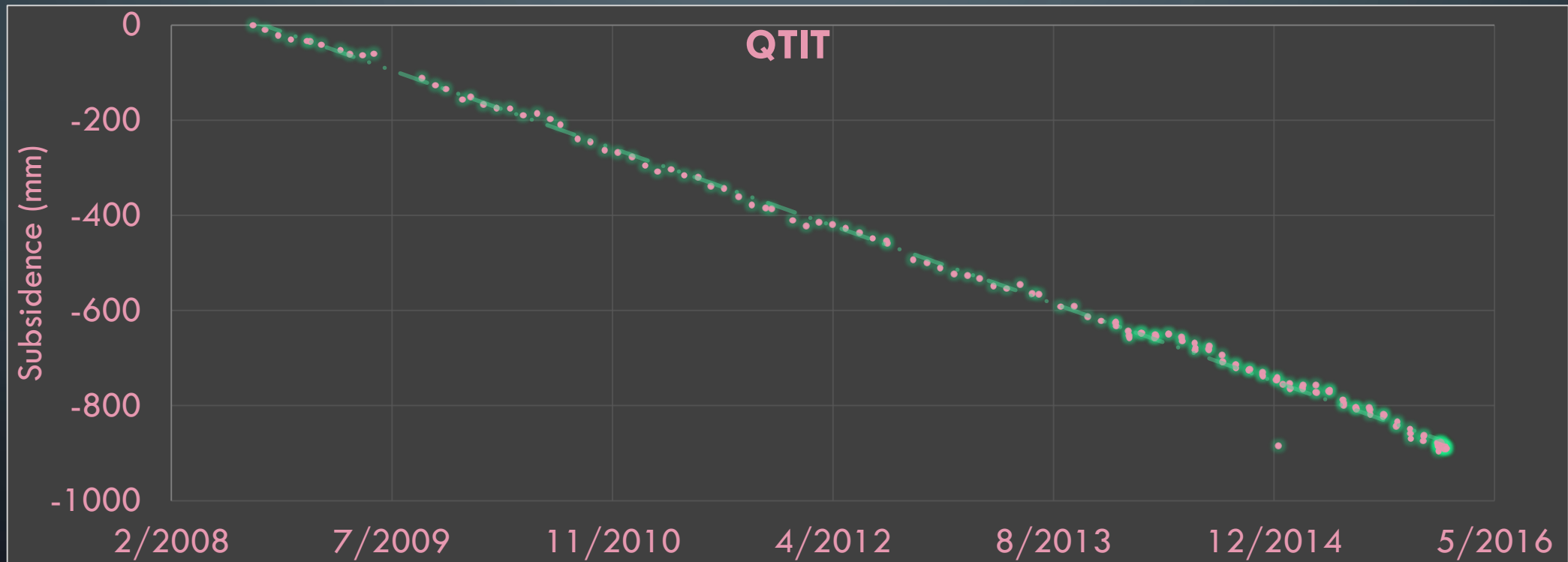
How to monitor Land Subsidence:

- High accuracy GPS units (Trimble NetsRs 5700) were used to measure land subsidence.
- The antenna is installed on a bipod which download data every 30 sec from the satellite.
- Five stations were selected for measuring of land subsidence.
- They were coded as QTIT, QTAG, SBKW, JHAK and KHAL.
- The obtained data is as follows



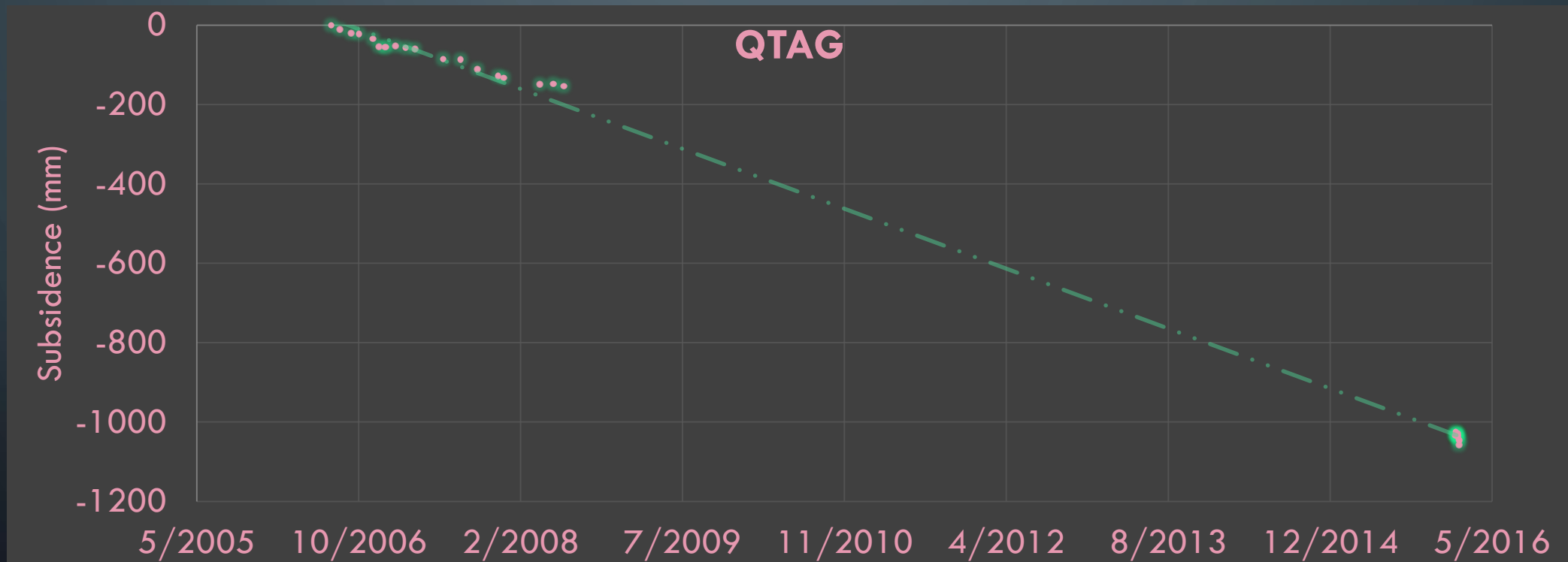
The total subsidence recorded by this station in 7 years and 4 months was about 890 mm (2.91 feet).

The annual subsidence recorded by this station was about 120.2 mm per annum

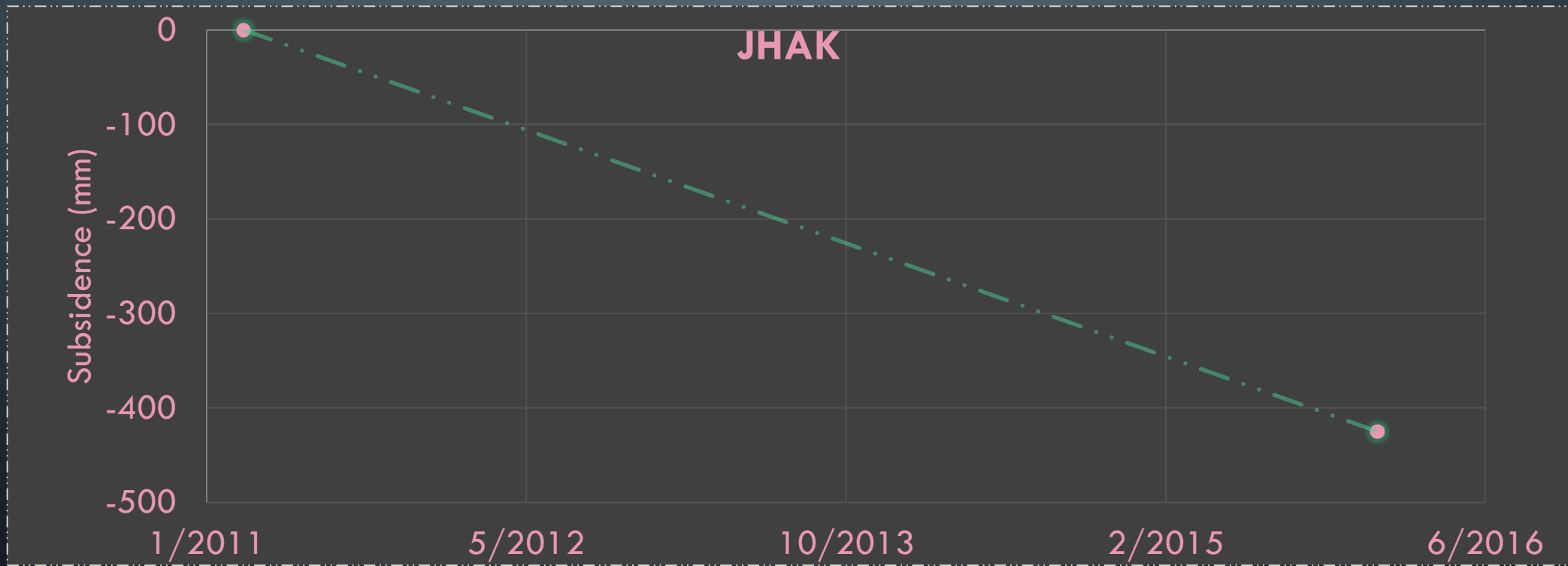


The total subsidence recorded at this station in 9 years and 7 months was about 1036 mm (3.39 feet).

The annual subsidence recorded here was about 106.8 mm per annum.

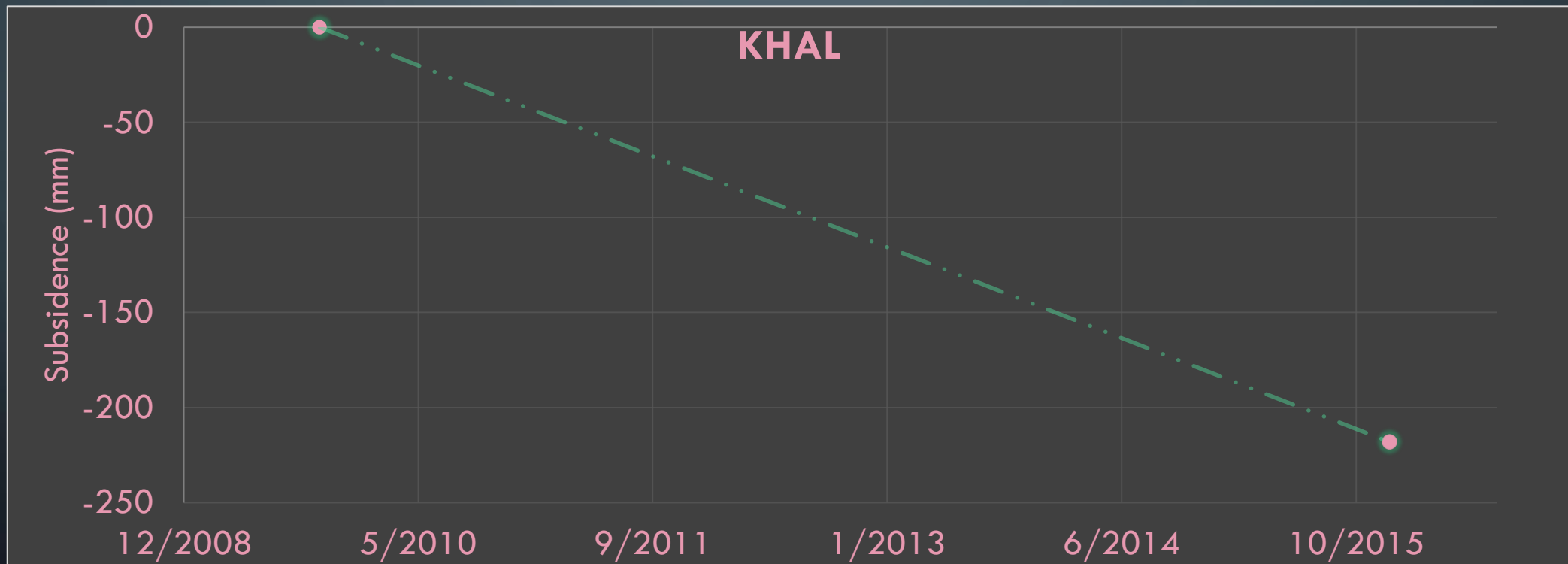


The total subsidence of land observed at this station in 4 years and 10 months was about 430 mm (1.4 feet).
The annual decline recorded here was about 88.3 mm per annum.



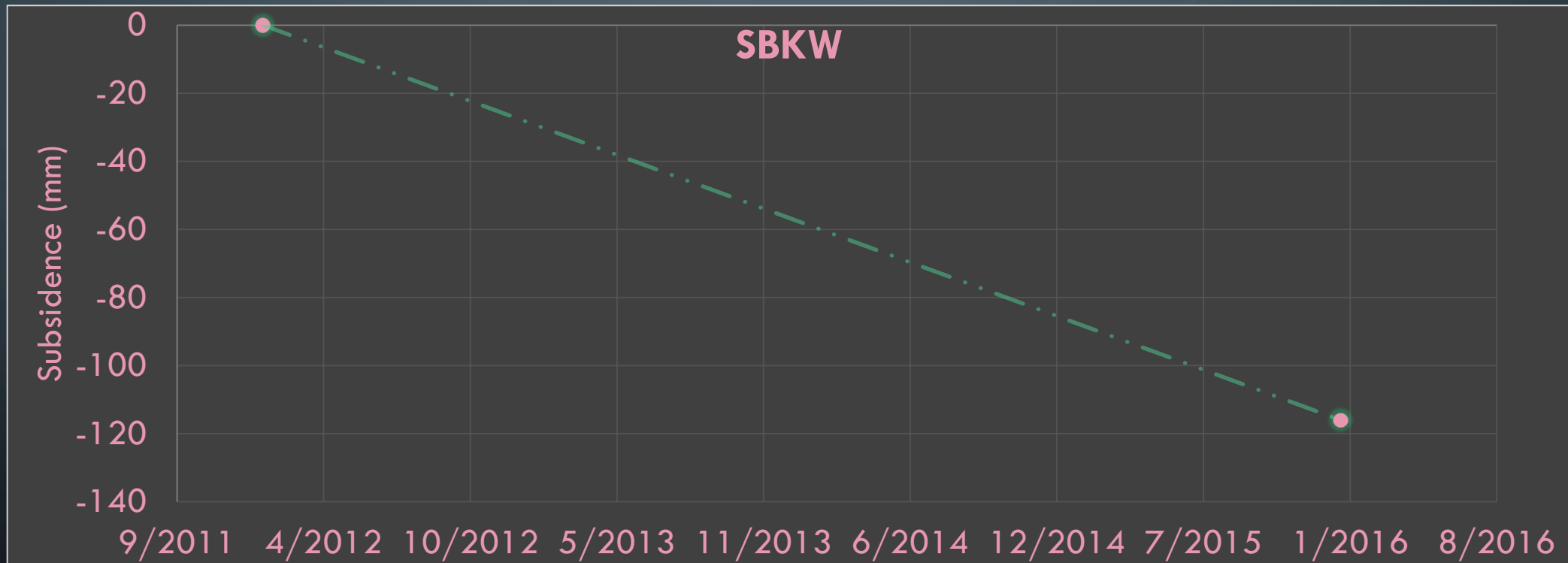
The total subsidence of land recorded by this station in 6 years and 2 months was about 218 mm (0.7 feet).

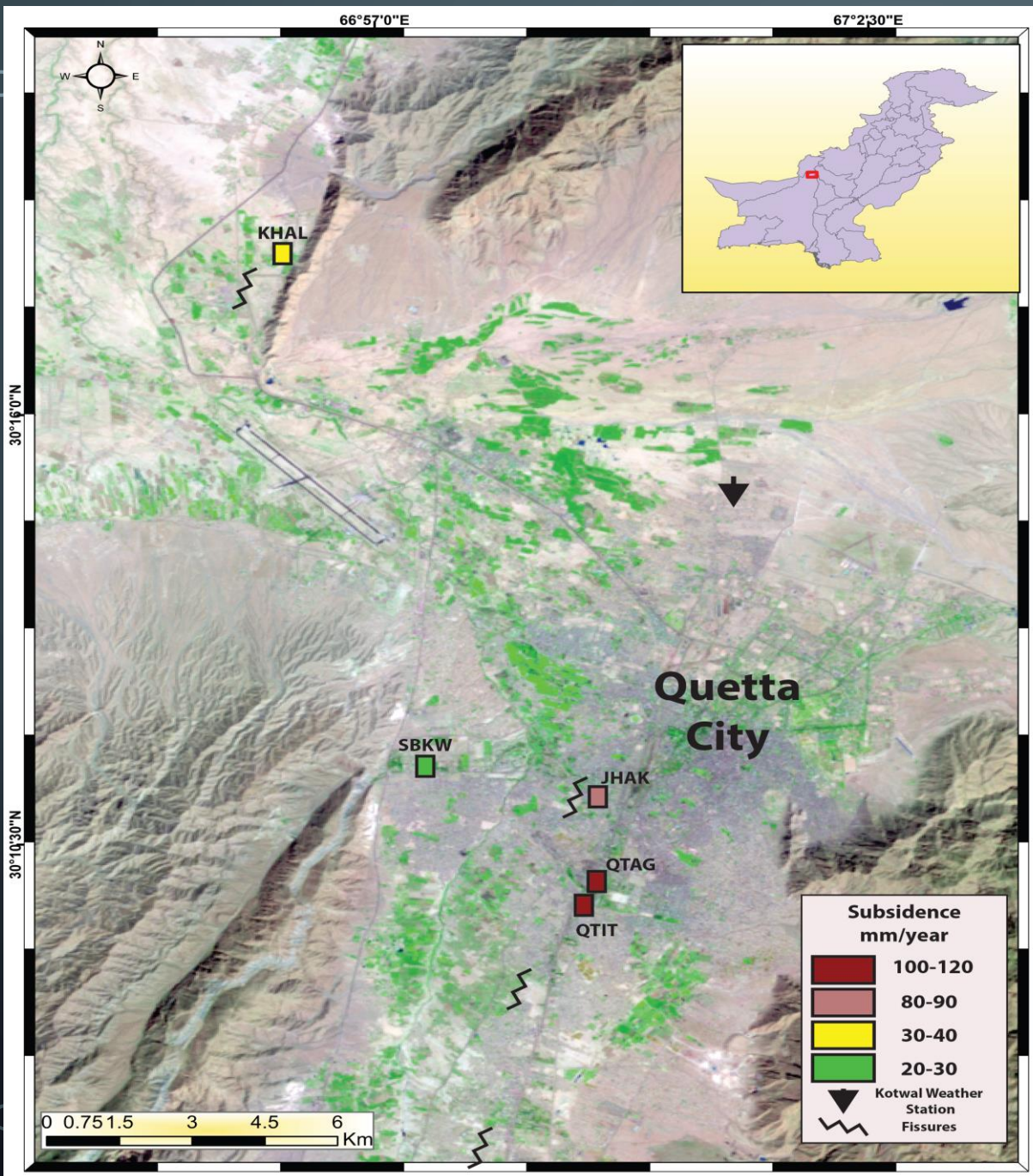
The annual subsidence observed here was about 35.1 mm per annum.



The total subsidence recorded by this station in 4 years was about 116 mm (0.3 feet).

The annual subsidence recorded here was about 29 mm per annum

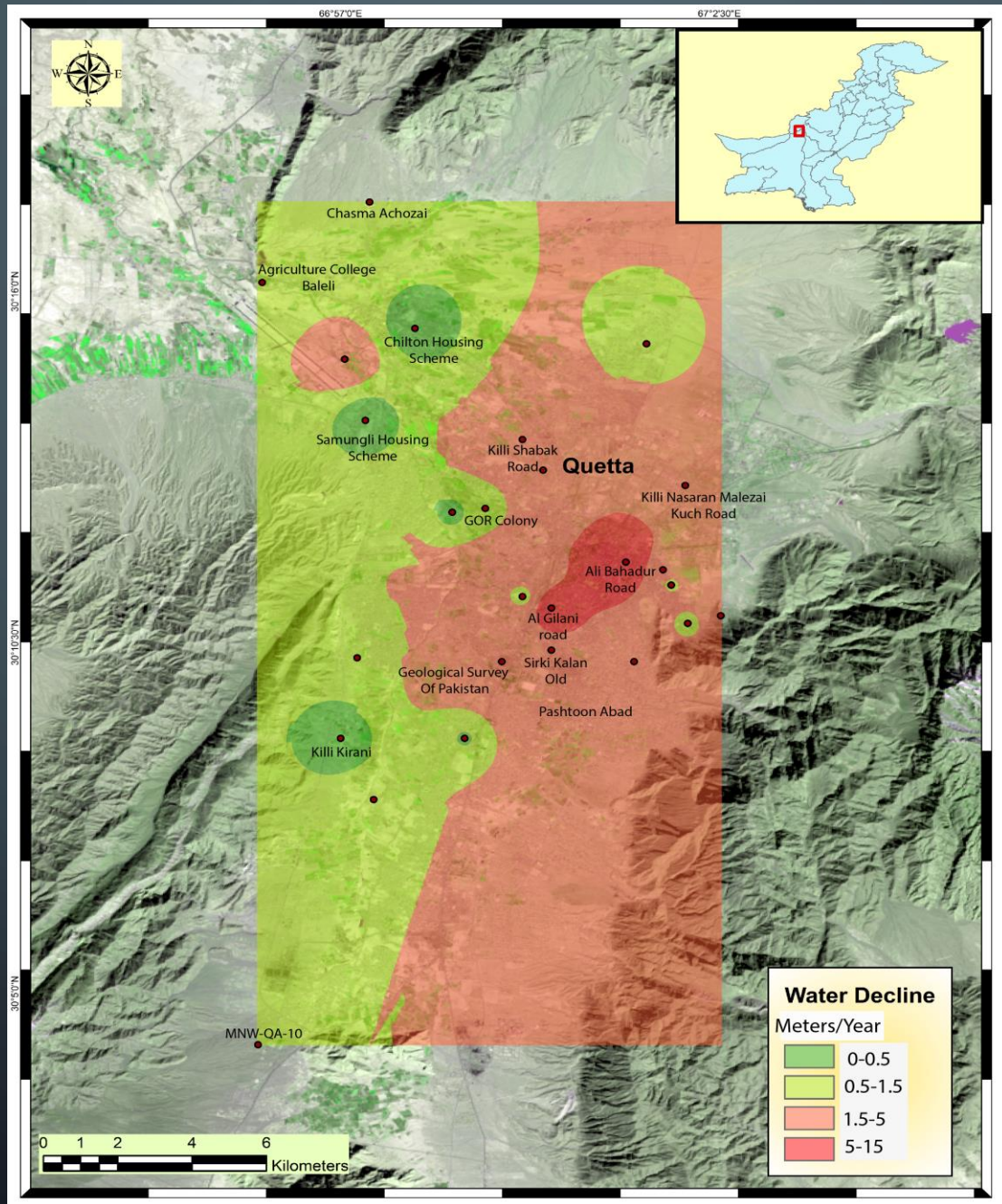




More Subsidence rate is recorded at the central valley as compared to the flanks. This is because the thickness of compressible sediments/unconsolidated material is higher in the central valley as compared to the flanks.

Causes of land subsidence: Water Decline

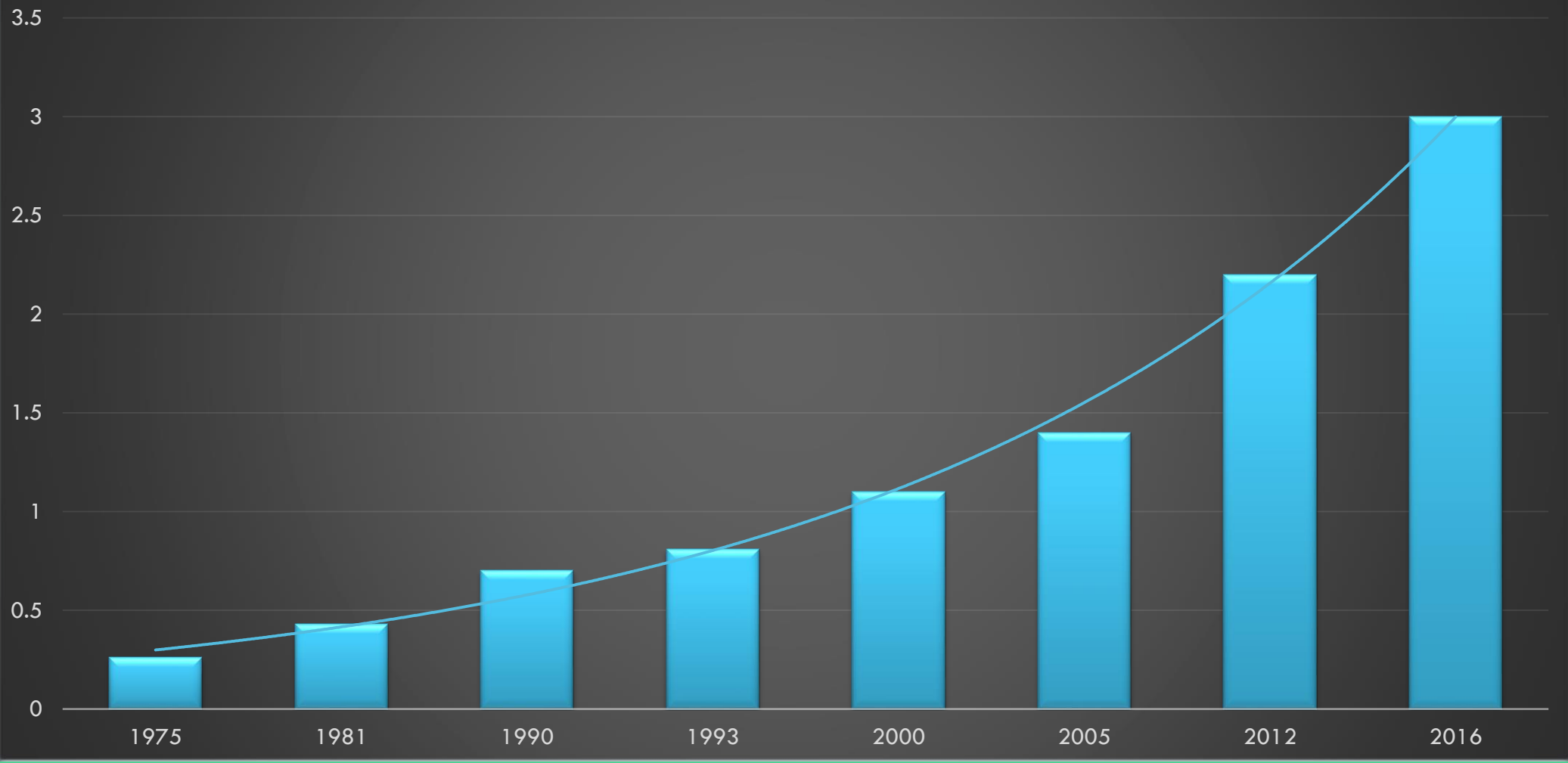
- The primary cause of Land subsidence in Quetta Valley is the water Decline.
- During the study, water decline data of 41 observation wells were collected from I&P, WASA of the year 2010-2015.
- Water is declining at substantial rate in the valley.
- The data revealed that the water is declining at 1.5-5 m/y.



Population

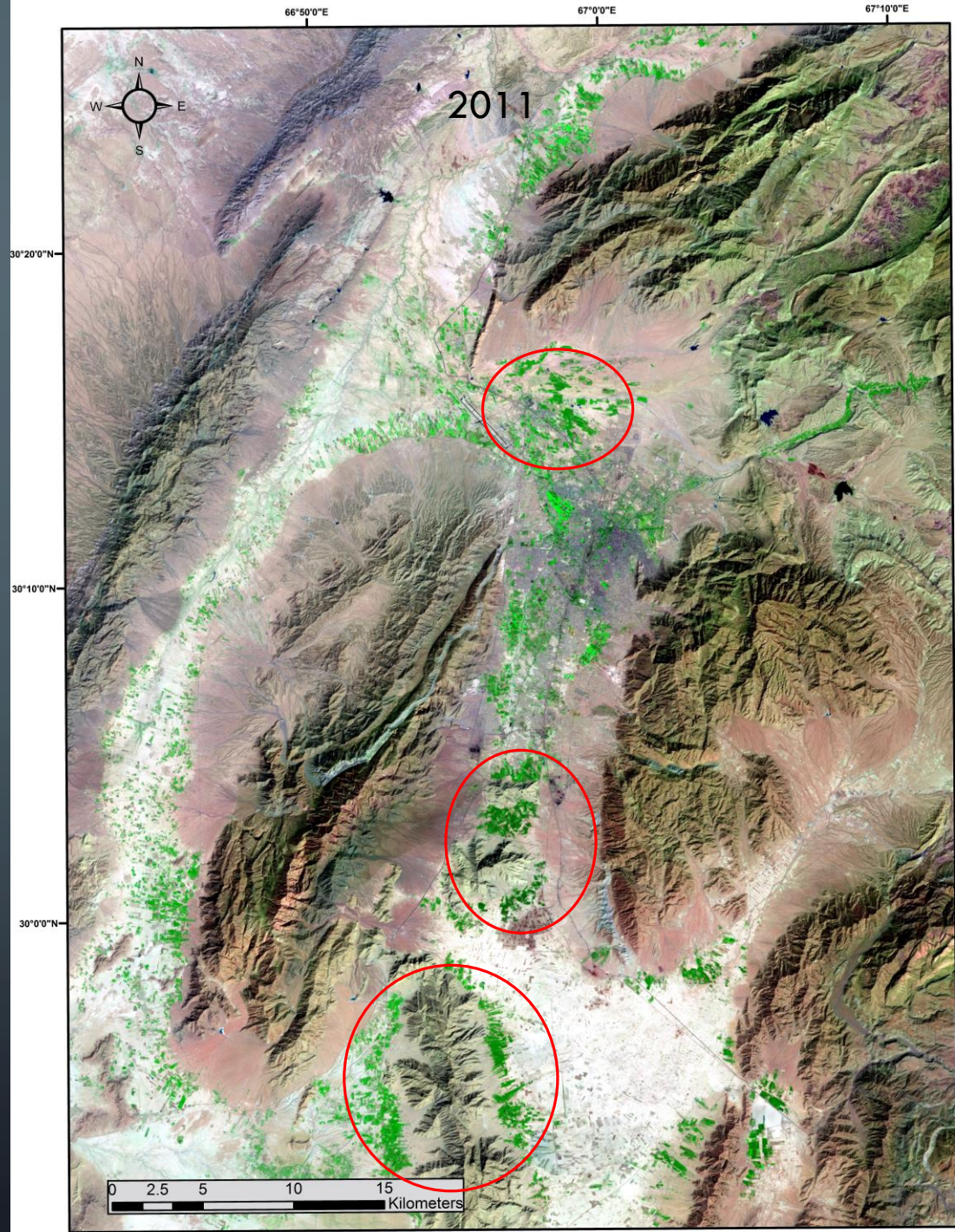
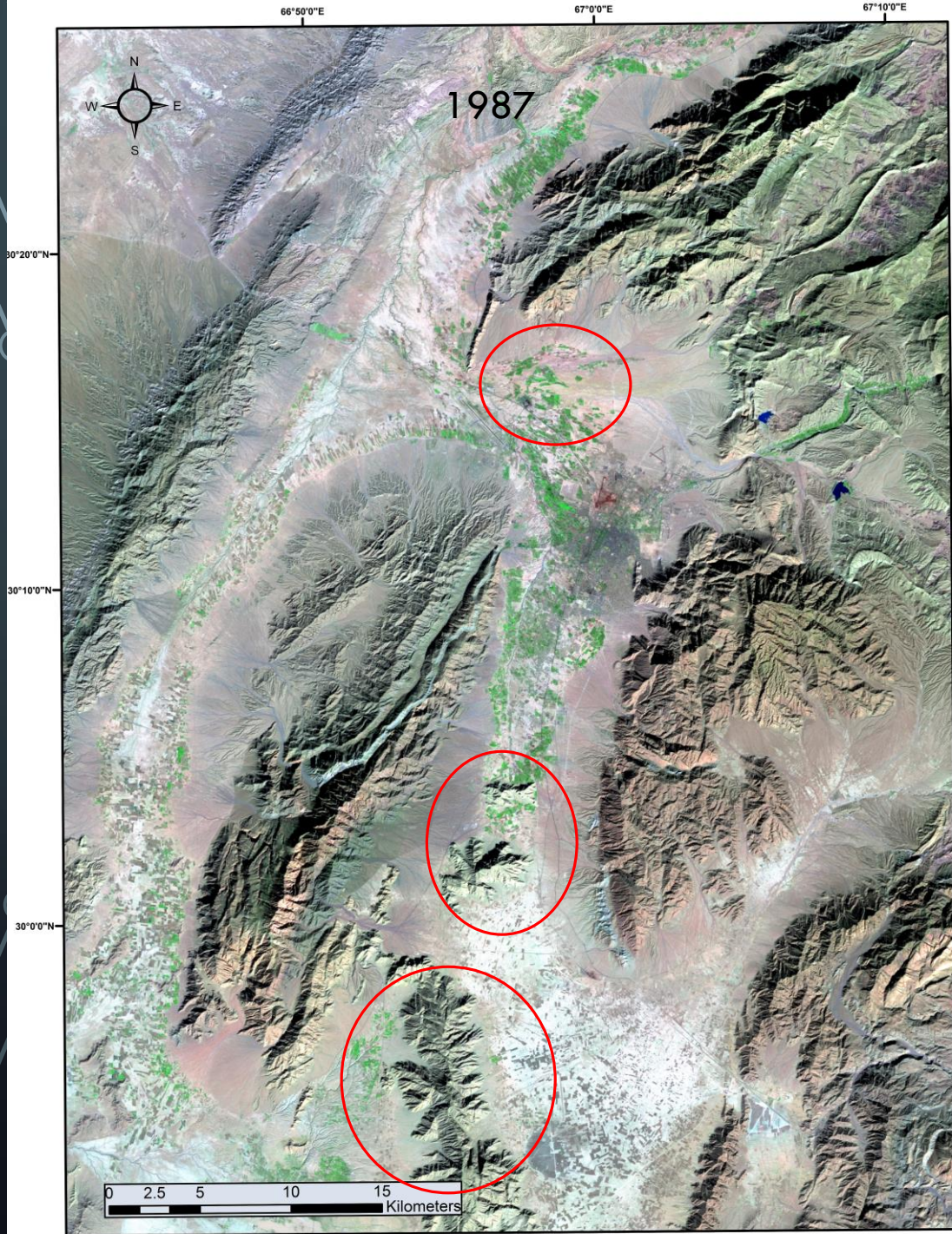
- Quetta valley water needs were fulfilled by Karezes until 1970`s.
- The afghan refugees and urbanization increased the population growth by several folds.
- The population of Quetta valley increased from 0.26 million in 1975 to 3 million in 2016.
- This huge population is an overburden on the aquifer of Quetta valley.

Population (millions)



Agriculture

- Agriculture in the valley has increased dramatically in the last decade as more people earn their livelihood from agriculture.
- Too much water is being used for this purpose, it is one of major reasons of the groundwater drawdown.
- Two satellite images, obtained from USGS (GLOVIS), were processed in ArcGIS for the purpose to see the change in agriculture through time.
- The agriculture has dramatically increased in the northern and southern end of Quetta valley



Illegal Drillings:

- The extraction of ground water resources from the already depleted aquifer of Quetta sub basin is still continued without any checks from the government side.
- Private illegal drillers are drilling the sub-surface of Quetta valley without any permission from the govt.
- According to the mayor of the city, currently about 3,000 wells are drawing water resources from the already exhausted and stressed aquifer.
- To illustrate the congestion of tube wells in Quetta valley, the well location within an area of 1.3 km² was observed. Out of the 20 production wells only 1 well is owned by government and 19 wells are privately (Illegally) owned.

66°58'0"E

66°58'15"E

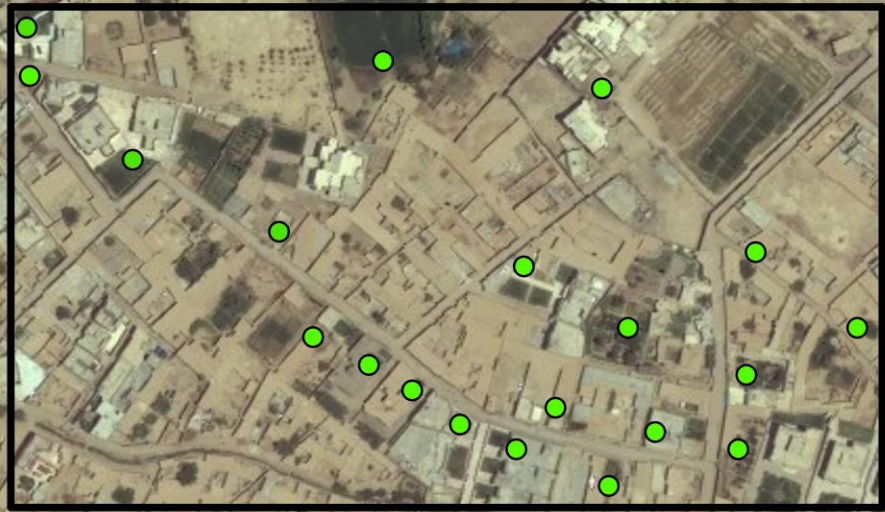
30°15'15"N

30°15'0"N

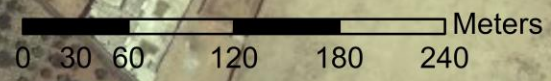


Provincial Disaster Management Authority

Air Port Road



 **Production Well**

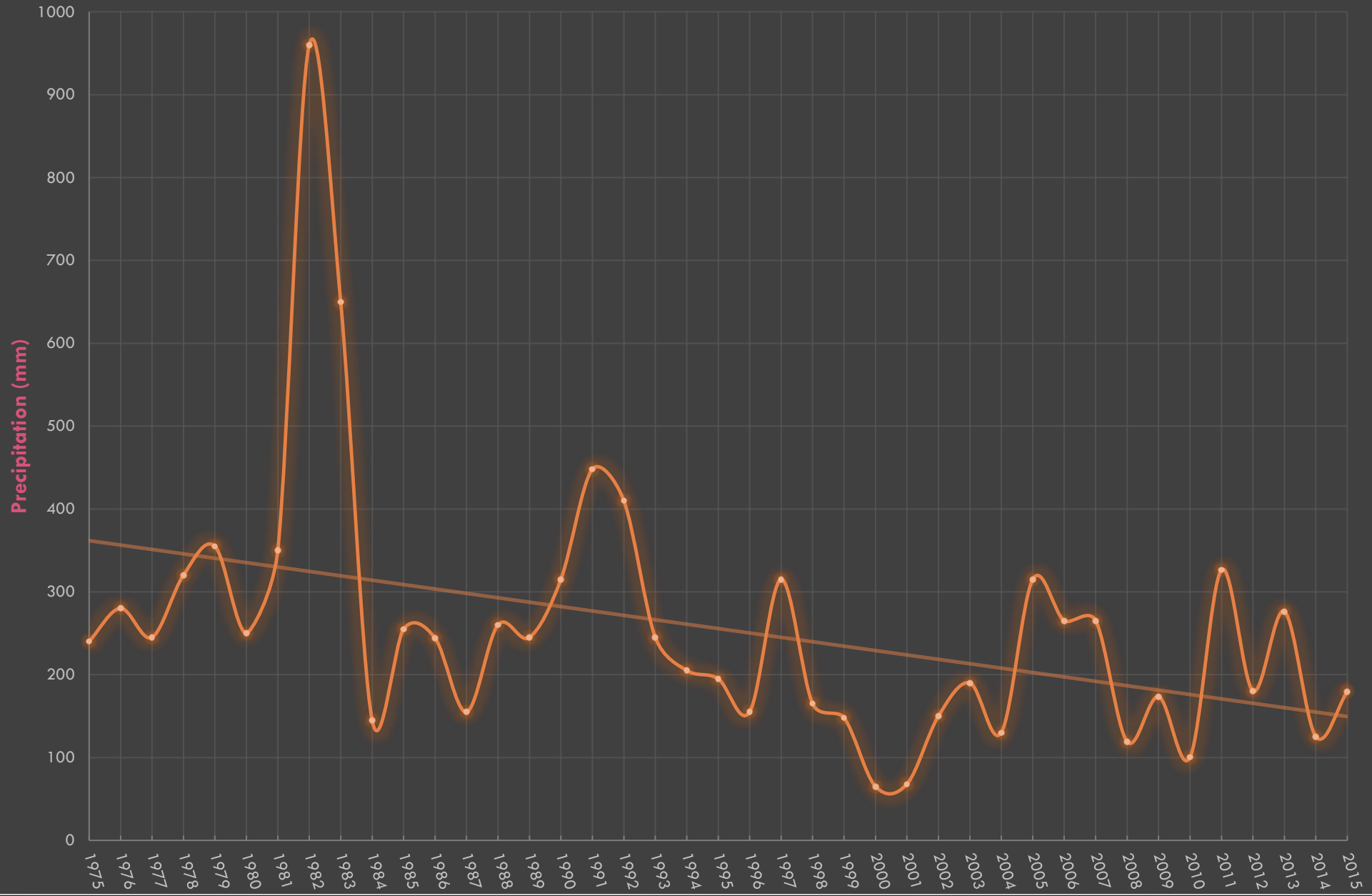


Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

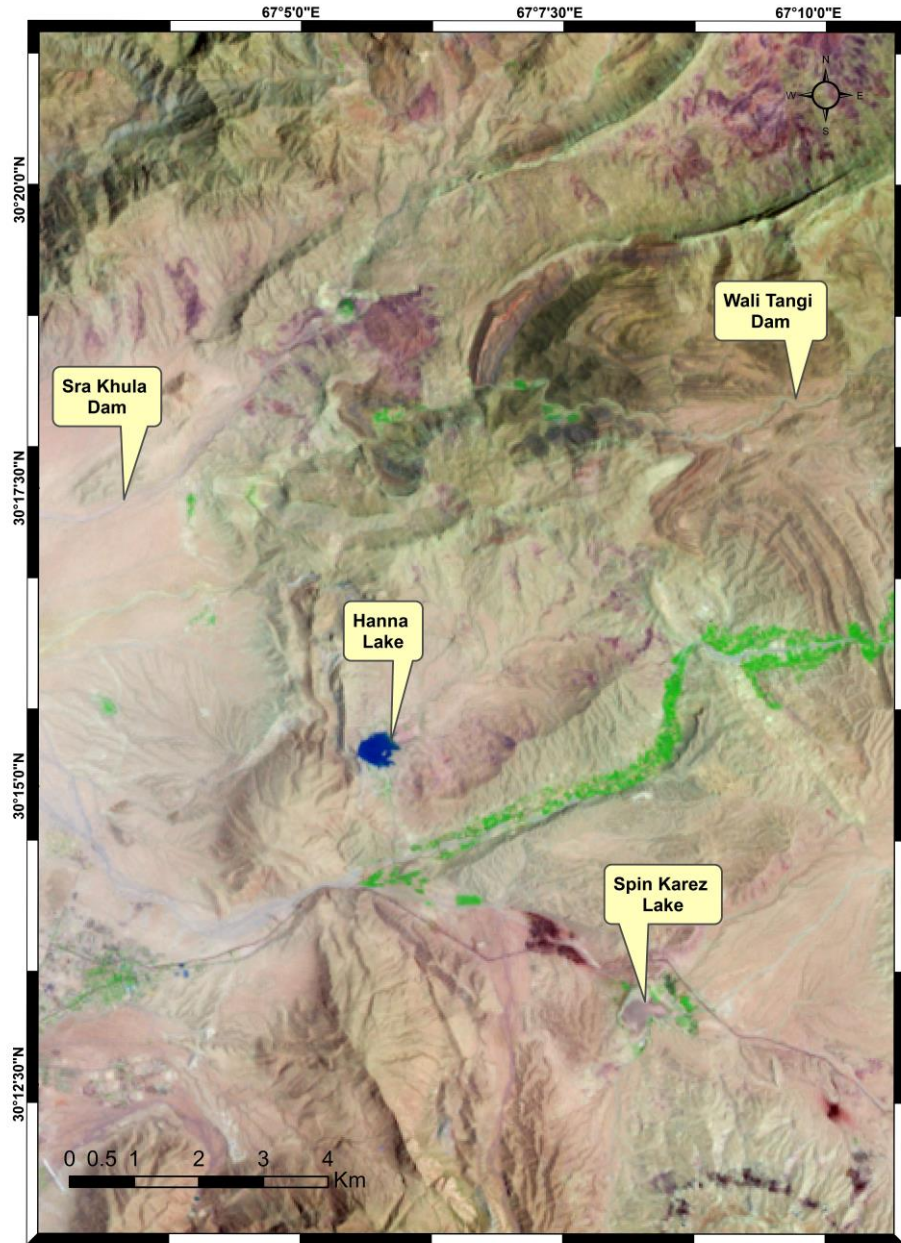
Precipitation:

- Quetta valley had been hit by severe droughts in the past three decades.
- The most intense drought occurred during 1998-2002.
- Most of the dams around the valley were completely dried up.
- The average rainfall is again decreasing in the year 2014-15 reaching only 152 mm/y.

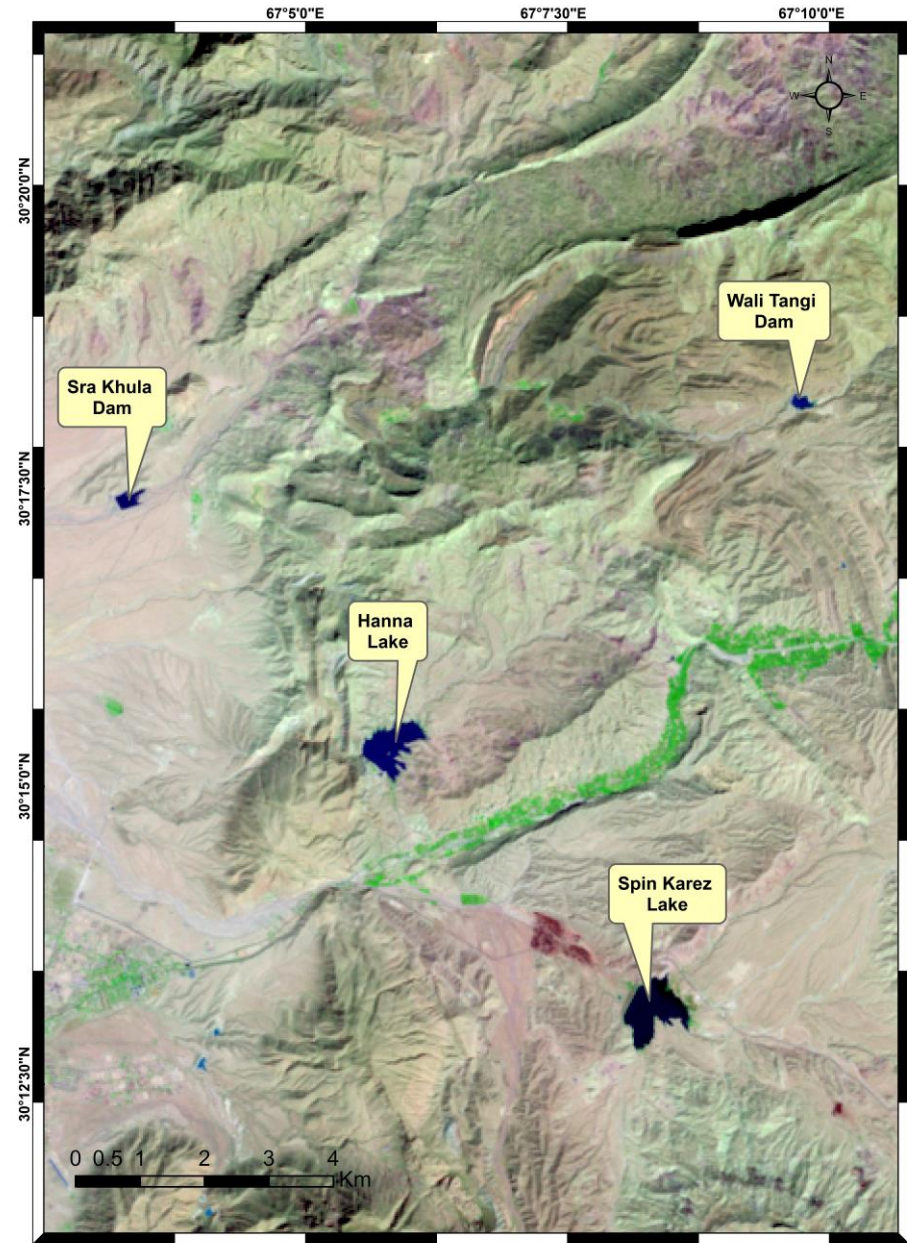
KILLI KOTWAL STATION



2001



2011



Effects Of Land Subsidence: Fissures

- Land subsidence is developing fissures in Quetta valley at different locations.
- 1000 m long and 2-3 m wide fissures were observed during the study.
- These cracks will damage more building in the future if the trend continues.
- The sewage water is penetrating in these cracks making the underground water pollute that will ultimately result in more water borne diseases.















Remedies/Recommendations

- Proper network of observation wells and data collection needs to be established to monitor and identify water decline zones with more accuracy.
- The waste water of Quetta valley needs to be recycled for agriculture use, this will minimize wastage of ground water.
- Limitation on wastage of water needs to be imposed.
- Public mass awareness may be created through print media, electronic media and public meetings to avoid excessive misuse of ground water.

Remedies/Recommendations

- Complete and effective ban must be imposed on all illegal drillings in the valley.
- Delay action dam's needs to be built to reclaim the water table.
- A complete ban on agriculture in the valley needs to be imposed to protect the aquifer from drying up.
- Flat rate on tube wells needs to be stopped to save unnecessary wastage of water.
- Stop free supply of water and put a price on it.

The background is a dark blue gradient. In the four corners, there are decorative white circuit-like patterns consisting of lines and small circles, resembling a PCB layout.

Thank you

najeebullahkakar991@gmail.com