Satellite Based Monitoring of Groundwater Storage Variations Over Indus Basin

(A joint venture of PCRWR, University of Washington and NASA)

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For the extraction of GRACE based TWS, the Centre for Space Research at University of Taxes (CSR) Release 05 Level-2 data product called "CSR RL05 L2" is used in this study. GRACE monthly gravity field datasets are provided by the NASA PODAAC (ftp://podaac.jpl.nasa.gov/allData/grace/L2/CSR/RL05/). The data smoothing, de-correlation and signal restoration techniques have been applied for the extraction of TWS.

The Fig. 1 & 2 shows the monthly Groundwater Storage (GWS) variations over Upper Indus Plain during the months of November and December, 2016 whereas the GWS variations in January, 2017 is reflected in Fig. 3. From November to January, the monthly GWS analysis indicates that groundwater storage has sharply decreased which was peaked in October, 2016 (57.8 km^3). This decrease in storage is attributed to the low rainfall (post-monsoon) plus pumping effect. During the period from December 2016 to January 2017, It is observed that the groundwater storage has been decreased with an average rate of 0.99 km^3/per month with a total loss of about 3.0 km^3. The major change in groundwater storage has been noticed in the areas of Upper Thal and Rechna and whole Chaj doabs. The resultant changes in groundwater storage over Upper Indus Plain during the months of November 2016 through January, 2017 are approximately estimated as 31.4 km^3, -28.2 km^3 and -29.3 km^3, respectively (Fig. 4).

<u>For groundwater Decision Making</u>

On the basis of the analysis conducted from November 2016 to January 2017, a depletion trend (drawdown) in groundwater storage is appeared. Specifically, the areas of Chaj and Rechna doabs, upper Thal doab including Lahore and Kasur districts of Bari doab are found to be under stressed in January, 2017 and need careful water management and planning (regulation of groundwater pumping).

Users in this region can expect the reduction in GWS to decline further and a deeper depth to pump ground water.

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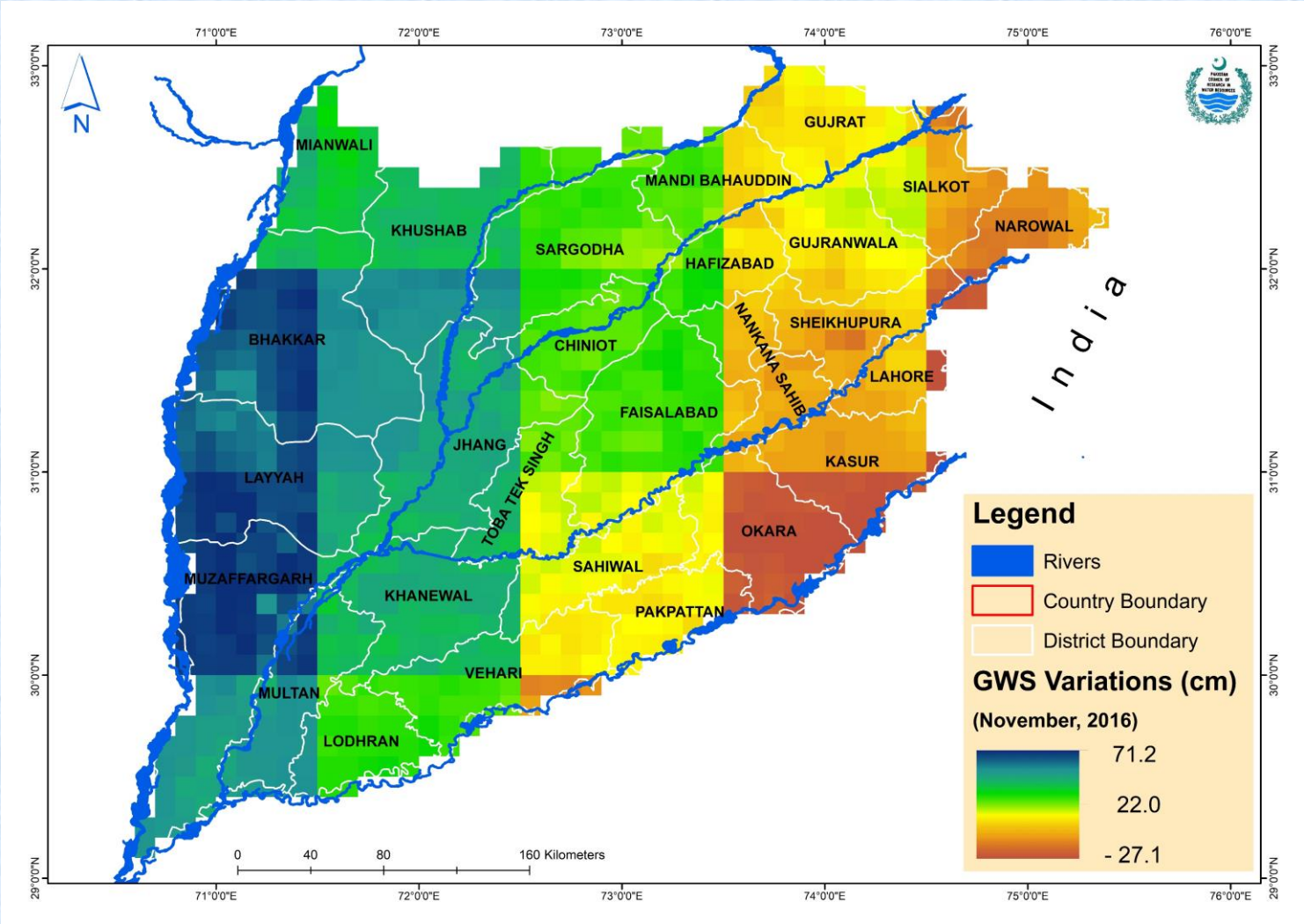

Fig. 1: Monthly GWS variations over Upper Indus Plain during November, 2016

Warning: The resolution shown here is not GRACE native resolution. An assessment of groundwater storage anomalies at sub-grid of GRACE (10 km pixel) has been achieved on the basis of the 10 km VIC hydrologic model exclusively. Such a map is therefore subject to the hydrologic model uncertainty at that scale. Users should consult with PCRWR before making any decision on the basis of potential trends shown at 10 km scale.

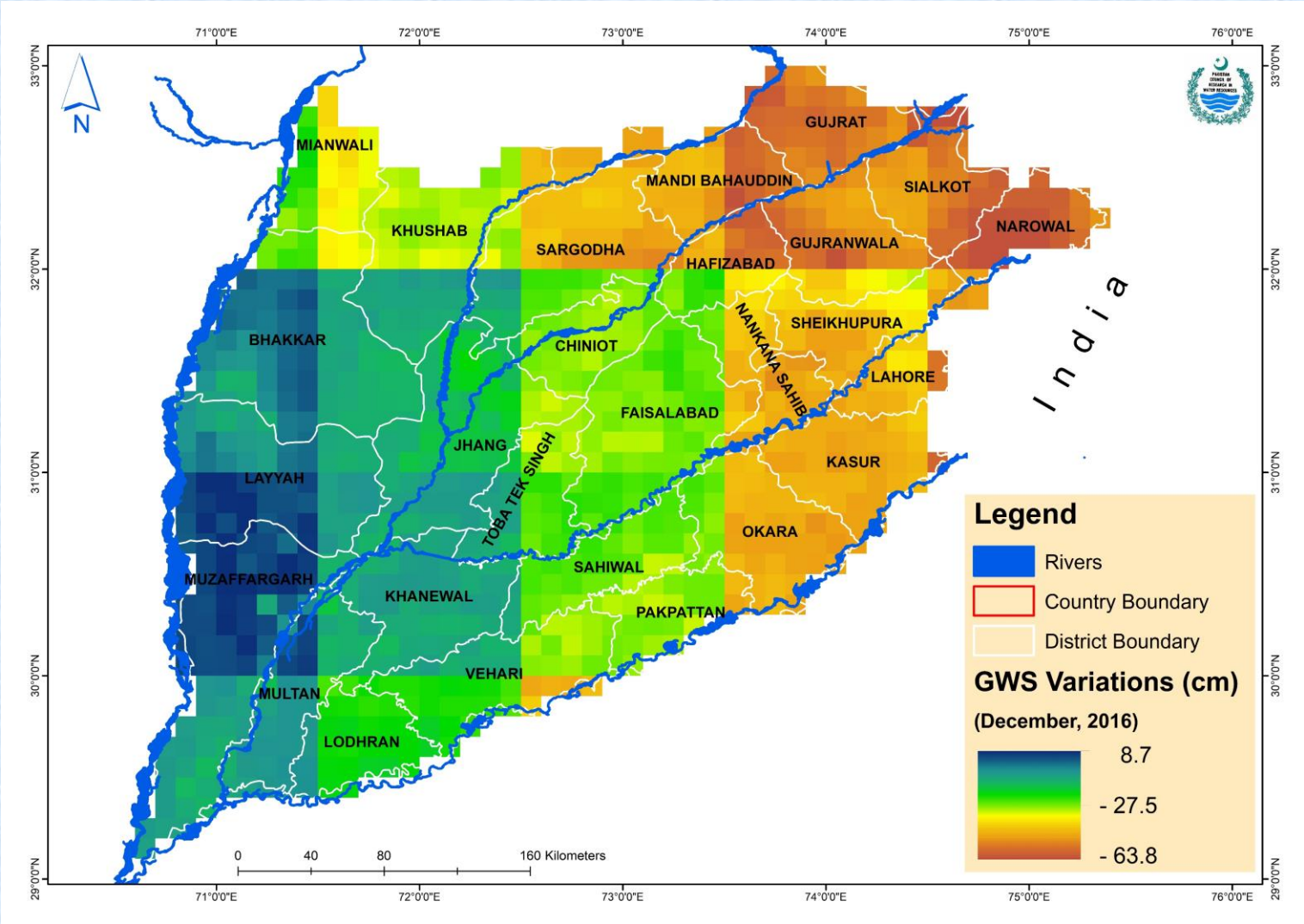

Fig. 2: Monthly GWS variations over Upper Indus Plain during December, 2016

Warning: The resolution shown here is not GRACE native resolution. An assessment of groundwater storage anomalies at sub-grid of GRACE (10 km pixel) has been achieved on the basis of the 10 km VIC hydrologic model exclusively. Such a map is therefore subject to the hydrologic model uncertainty at that scale. Users should consult with PCRWR before making any decision on the basis of potential trends shown at 10 km scale.

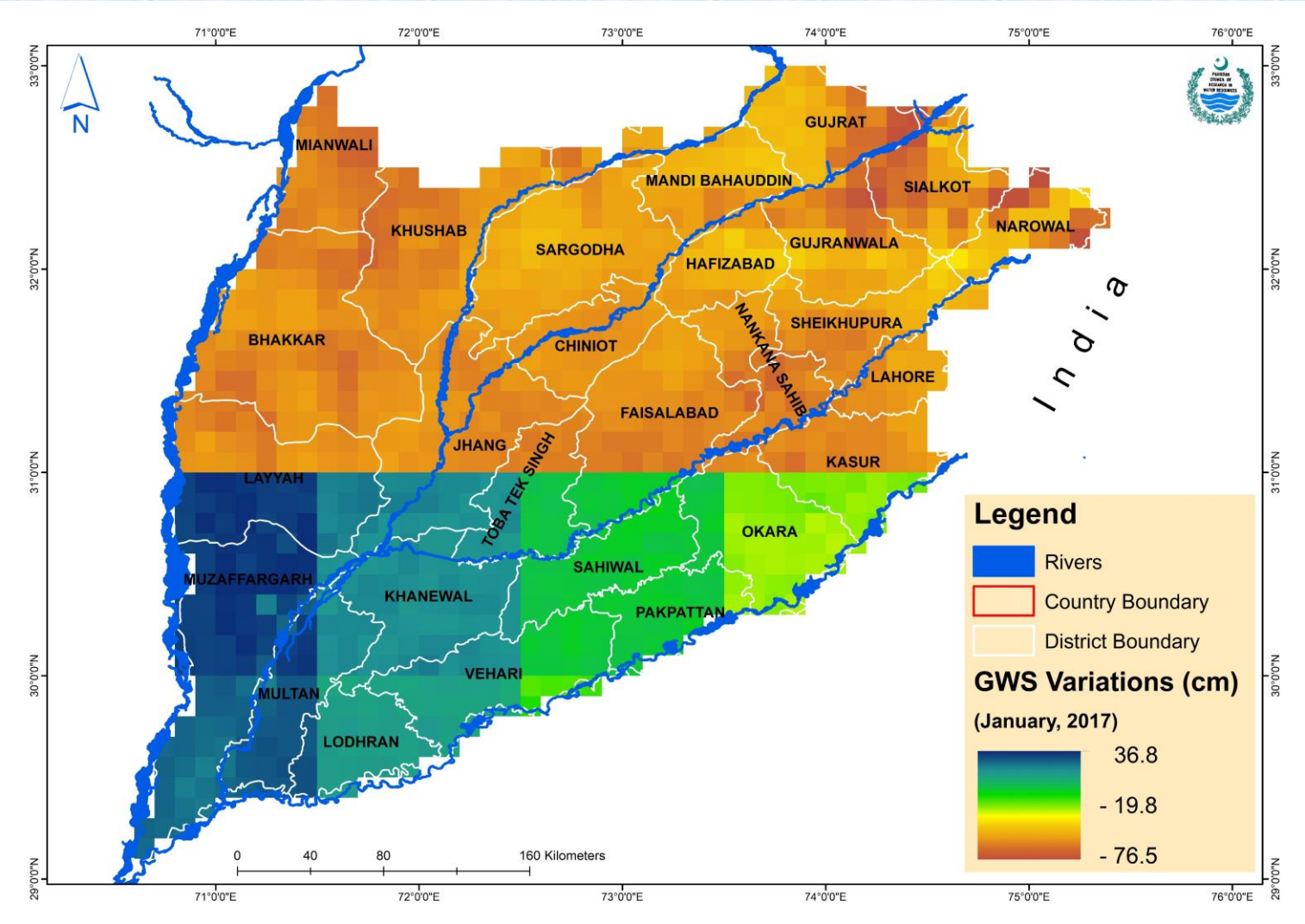

Fig. 3: Monthly GWS variations over Upper Indus Plain during January, 2017

Warning: The resolution shown here is not GRACE native resolution. An assessment of groundwater storage anomalies at sub-grid of GRACE (10 km pixel) has been achieved on the basis of the 10 km VIC hydrologic model exclusively. Such a map is therefore subject to the hydrologic model uncertainty at that scale. Users should consult with PCRWR before making any decision on the basis of potential trends shown at 10 km scale.

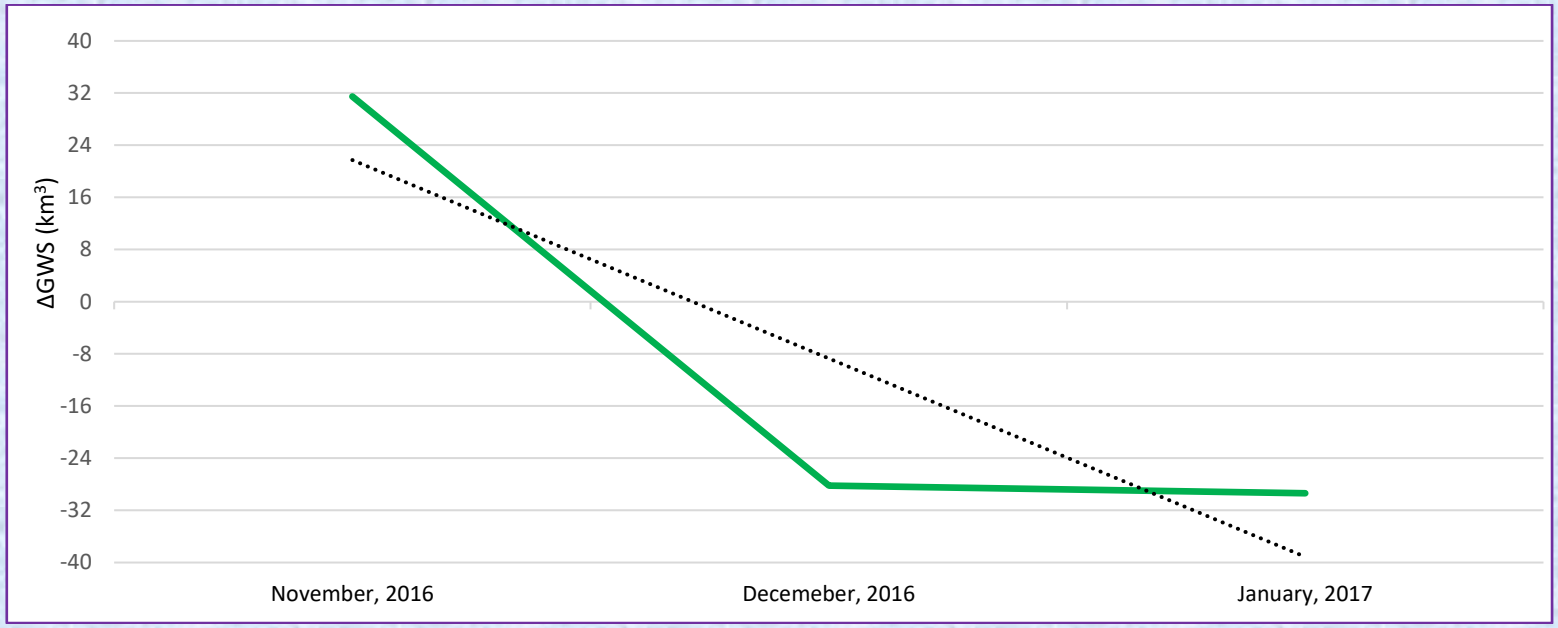

Fig. 4: Mean Monthly GWS variations over Upper Indus Plain from November 2016 - January, 2017