FLOOD HAZARD MAPPING AND RISK ZONING OF THE NULLAH DEG, PAKISTAN USING HYDRAULIC SIMULATION MODEL (A CASE STUDY)

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ABSTRACT: *The 2014 flood event in the Nullah Deg inundated and caused the highest massive losses in the vicinity of Narowal, Sialkot and Muridke Various methodologies have been demonstrated to flood administration and diminution and the outcomes of flood dangers until now. One of the utilized techniques is the Flood Plain Zoning (FPZ) technique utilizing hydraulic analysis that depends on a hydraulic model. Hydraulic models can draw the water surface profile in each individual segment. At to start with, the flood period is given; then the water surface level in diverse cross sections is calculated utilizing the model, accordingly these focuses over the topographic arrangement of the zone are compared, to determine the flood plain zone; lastly we can make obliged forecasts to flood organization on the danger of flood. The present study area is Nullah Deg, northern eastern Punjab, Pakistan and its reach length was 41 km long. An accurate technique to determination of the flood plain zone is necessary to prevent the probable risks. In this study, HEC-RAS model to hydraulics estimations and the ArcGIS are used to excerpt the cross section by topographic strategies of study area and flood plain zoning in Geographical Information System with return periods: 10, 25, 50, 100, 200 and 1000 years. The regions that were at hazard were estimated and lastly numerous approaches were suggested to avert the zone reduction and the impairments of flood. The findings of this study will provide the suitable information to inhabitants of the area who are at-risk and policy makers to make the adoptive strategies to overcome the adverse impacts of flood.*

Keywords: Flood plain Zoning, HEC-RAS, Nullah Deg, ArcGIS, HEC-GeoRAS

INTRODUCTION

Flood plain zoning is a critical component of flood risk reduction management. Flood risk maps, demonstrating the degree and expected water profundities/levels of a region overflowed in three situations, a low likelihood situation or compelling occasions, in a medium likelihood situation and if proper a high likelihood situation. Flood danger maps, might likewise be arranged for the regions overflowed under these situations demonstrating potential populace, financial exercises and the earth at potential danger from flooding, and other data that Member States may discover valuable to incorporate, for occurrence different wellsprings of contamination. Stream and flash flooding for the most part result from unusually high precipitation over a moderately brief period: Hours for flash floods; Days for stream floods. Quick snow melt can bring more water into the hydrological framework than can be sufficiently depleted; prompting what is for the most part called spring floods. Overwhelming precipitation amid the tropical stormy season can prompt rainstorm flows, which can influence streams and might likewise happen as flash flooding. Sedimentation of stream quaint little inns of water catchment regions can intensify conditions prompting stream valley flows. Deforestation and clearing over area can fundamentally expand the danger of flash flooding.

[1] defined that HEC-GeoRAS is used effectively to demonstrate inundating, demarcation of floodplains and in formulating the channel geometry data. He related the DSI studies of floodplain by using outdated approaches and determined that the use of new model in demarcation of floodplain diminish the exertions about 60% which also provisions the use of new models in floodplain delimitation and planning of bridge geometry.

Although in the Flood Appraisal Handbook-FEH [2], using the suggested distribution of Comprehensive Logistic, the approximations can be completed up to the half dimension of record i.e., N/2 on the basis of single site examination. Supernumerary alternative is the decentralized frequency-statistics; though, there are probable likelihoods that the accessible catchments may not adequate great return-period occasions.

[3] calculated that due to these difficulties, there are certain constraints on the Single-site frequency-analysis. The endorsements in the deluge revisions report-FSR [4] recommend that for a record-length of N years, the inundations of reoccurrence period up to 2N can be assessed by the Generalized Extreme Value distribution.

[5] used HEC-RAS for floodplain demarcation of the river reach from downstream of Darya Khan Bridge to Taunsa Barrage. He quantified those HEC-RAS outcomes with the use of ArcGIS assisted in the influential of the inundation extent. [6] studied the flood zoning and mapping by using GIS and hydraulic model. In this study 40 km reach of Chenab River from Marala to Alexandra Bridge was selected for flood analysis. The computed water depths were computed with a physical model study at different locations. The comparison of water depths shows that the results are within the permissible limits.

[7] studied the flood in Muzaffargarh district due to river Chenab upstream and downstream of Sher Shah Bridge. Gumble distribution was applied for analysis and the results of DFW software for frequency analysis were found satisfactory. The HECRAS model was applied to get the water depth due to some specific types of floods. Based upon the energy equation, simulations obtained by employing HEC-RAS are reliable.

A few sections of District Narowal, Sialkot and Tehsil Muridke have been the loss of genuine flooding over the past various years with late amazing in 2014 are still at peril of it in future. In the flood season, the rural area in the stream way zones furthermore a couple of settlements lie even inside the secured bunds. The floods cause loss of life and damage to agrarian area inside the flood plain. There were two primary driver of flooding, one was bringing level of water up in the stream and second purpose behind flood was a burst in the bunds-commonly old and hurt ones-that allows a downpour of water into the towns and cultivating landscapes. Abnormal state flood was passed on in Nullah Deg with around 2152 cumecs water going from the channel having a limit of 283 cumecs. Precise assessments of extent and recurrence of flood are required for arrangement and operation of water use and water control wander for flood plain definition, organization and for layout of structure. To anticipate the influenced zone because of an upcoming flood is likewise an imperative issue for administration. One of primary issues confronted by foundations amid the time of flooding is what zones ought to be uprooted. Flood zoning would give a method for highlighting the parts of urban areas, towns and the towns which be uprooted while actualizing a substitute arrangement. The main objective of the study was; to determine the water surface profile for flood magnitude of different return periods using HEC-RAS model and demarcation of different flood inundation risk mapping using HEC-GeoRAS and simulation of impact of floods on the protection areas along the selected reach.

MATERIALS AND METHODS

Description of Study Area

The present study was conducted on Deg Nullah northern eastern Punjab, Pakistan . It originated from Indian held Kashmir. Deg Nullah in its initial reach in Pakistan is a straight twisted channel with wide and shallow cross area and steep slope. A 41 Km reach was selected 1 km from upstream near Kingra Moor(Latitude 32°24'N and Longitude 74° 54'E) to downstream near Wahly village(Latitude 32°14'N and Longitude 74°42'E) , the study area is shown in Fig (1)The estimated population of farmers that is directly affected by Nullah Deg is around 0.5 million. The whole flood plain zone is about 2590 hectares.

METHODS

Using GIS, hydraulic modeling concluded in three phases; in first phase of preprocessing, Digital Elevation Model (DEM) was projected and study area zone designated by the projected coordinate system. After the extraction of research site and filtering of DEM, Triangular Irregular Network (TIN) was generated to form RAS layers Then RAS layers; Centerline, Banks, Flow path and XS cutlines were digitized. This concluded cross-sectional data then exported into HEC-RAS model for the second phase, in which primarily new project was created and units designated in metric system. Exported data then imported in HEC-RAS. Actual and extracted cross-sections compared for the calibration. Flow data of 1026, 1344, 1591, 1824, 2056 and 2602 cumecs entered for reoccurrence period of 10, 25, 50, 100, 200 and 1000 years and boundary conditions were defined to simulate the second phase results from HEC-RAS model and then these simulated results again exported into ArcGIS for the final phase post processing. In post processing, RAS exported file was converted from SDF to XML for the layer setup and then bounding polygons created for all seven flood values one by one. Flood delineations maps for all flood values

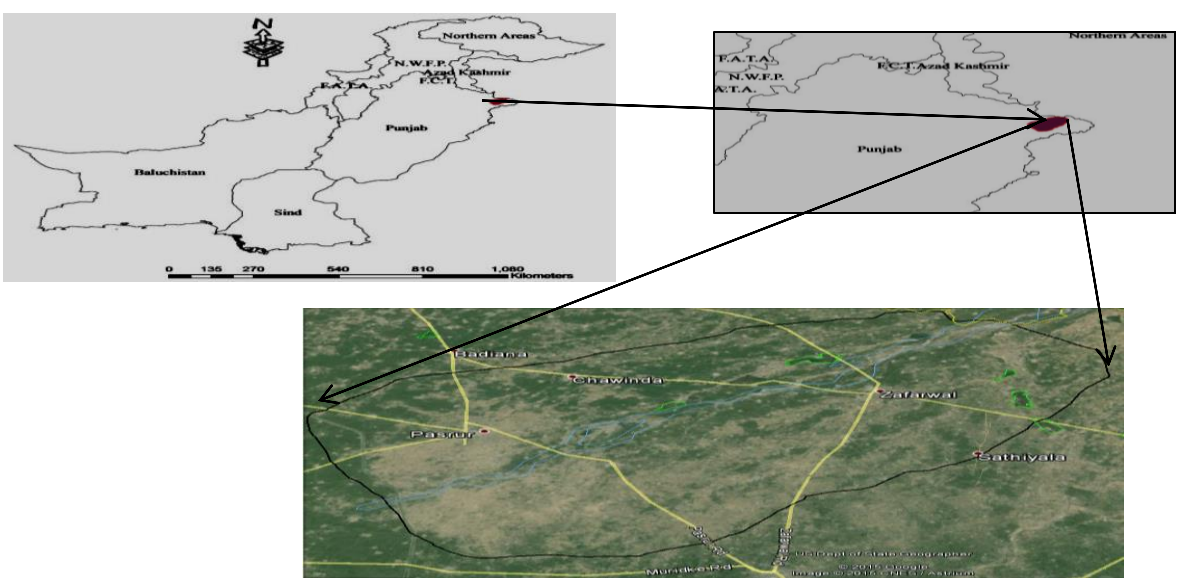

Figure 1 Study Area

Calculated after the bounding polygons creation. The outcome
was mapped with null values indicating the flood/inundated area while the remaining values indicating the non-flood area. In total, six inundation maps were created for each of the return periods.

RESULTS AND DISCUSSION

Flood event have very unadorned possessions on the settlements as it distresses the usual life of publics. Hundreds of acre cultivation land exaggerated and numerous societies evacuated from their towns to safe zones. The flood prejudiced standing crops over a great number of segments of land other than extricating a massive commonalities and destroying their households. Actual and extracted cross-sections have nearly close elevations as shown in Fig (2).

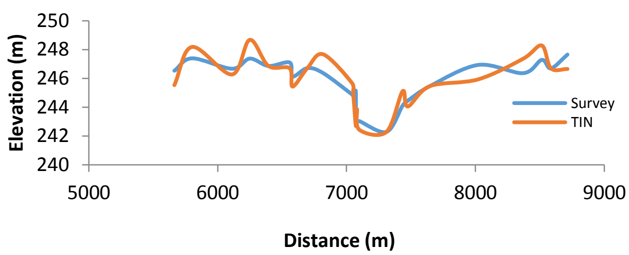

Figure 2 Comparison of measured and Extracted cross section

Flood Inundation maps at different return period and graphical representations of water depth, area and no of affected villages shown in Figure (3) and Figure (4). About fifty villages were inundated at every flood event with different water depth. Minimum water depth for 10 years return period was 0.35 meter and maximum was 2.41 meter. Maximum villages were in the range of 0.97 to 1.56 meter and its total area was 50 km^2. Minimum water depth for 25 years return perios was 0.52 meter and maximum was 3.28 meter. Maximum villages were in the range of 0.99 to 1.47 meter and its total area was 49 km^2.Minimum water depth for 50 years return perios was 0.52 meter and maximum was 4.15 meter. Maximum villages were in the range of 0.94 to 1.76 meter and its total area was 48 km^2. Minimum water depth for 100 years return perios was 0.45 meter and maximum was 5.70 meter. Maximum villages were in the range of 1.52 to 2.35 meter and its total area was 49 km^2. Minimum water depth for 200 years return perios was 0.30 meter and maximum was 6.70 meter. Maximum villages were in the range of 3.0 to 4.0 meter and its total area was 48 km^2. Minimum water depth for 1000 years return perios was 0.38 meter and maximum was 8.67 meter. Maximum villages were in the range of 4.0 to 5.3 meter and its total area was 56 km^2. the ramifications of this result is enormous when contrasted with the nature and degree of anthropogenic exercises and the significance of the floodplain in managing the characteristic hydrological fluxes in the bowl. The probability of introduction to flood danger may be higher passing by the way that street framework and other hydrologic designing structures inside of the bowl are associated with human exercises that are found near the Nullah Deg.

A closer examination of the spatial pattern of the immersion could be measured in light of the yearly land range that is foreseen to be immersed utilizing the determined estimations. Flood has a high limit and likelihood to extend to the whole floodplain as the years pass by. The outcome of this perception is the progressive development of a beginning scene with more ranges obligated to surge being watched. Also, the modelled pattern of immersion degree delineates a pitiful increment in the area zone immersed. This shows as an outcome of the increment in height on the northern piece of the bowl notwithstanding the decrease in the water surface displayed for the range. Basically, immersion of this zone depends on the foreseen water surface level.

CONCLUSION

Flood appraisal and observing is pivotal for ecological maintainability, especially inside of zones crossed by stream floodplain. This study has demonstrated the need of the helpfulness of geographic information System (GIS) as a spatial tool for inundation mapping inside of an ungauged bowl. Additionally, the study has shown the significance of delineating the recurrence of event of surge to the generation of the previously stated GIS-based flood mapping. The findings of the present study revealed that the results of the ArcView software and the HEC-RAS model have good correlations and they are proper and operative methods to use in future programming such as flood insurance, recreation constructions and so forth. The HEC-RAS gives the flood summary to the most exceedingly terrible flood strength. This profile will encourage receiving suitable flood humiliation relief measures. The inundation profiles for numerous flow strengths with different reoccurrence periods can be designed at any specified cross section of stream. Actual and extracted cross-sections have nearly close elevations.

RECOMMENDATIONS

Water surface profile ought to tend towards the basic stream line, by doing this the greatest stream can go through the base cross-segment. The LIDAR information of high determination ought to be utilized to separate the stream geometry as per ground substances. Better determination DEM may build the precision of cross segments to be extricated in light of the fact that the topographic information is not accessible at required scale. Other flood analysis software such as HEC-FDA and HEC-FIA could also be used for better assessment of flood prone areas and damage extents. Mapping and monitoring floods should be a continuous activity. There is the need to collect field data especially during the flood season each year. This would provide enough field data for accuracy assessements making future flood mapping and monitoring more accurate. This hopefully would lead to the creation of a database of time series geo-referenced flood information useful for management.

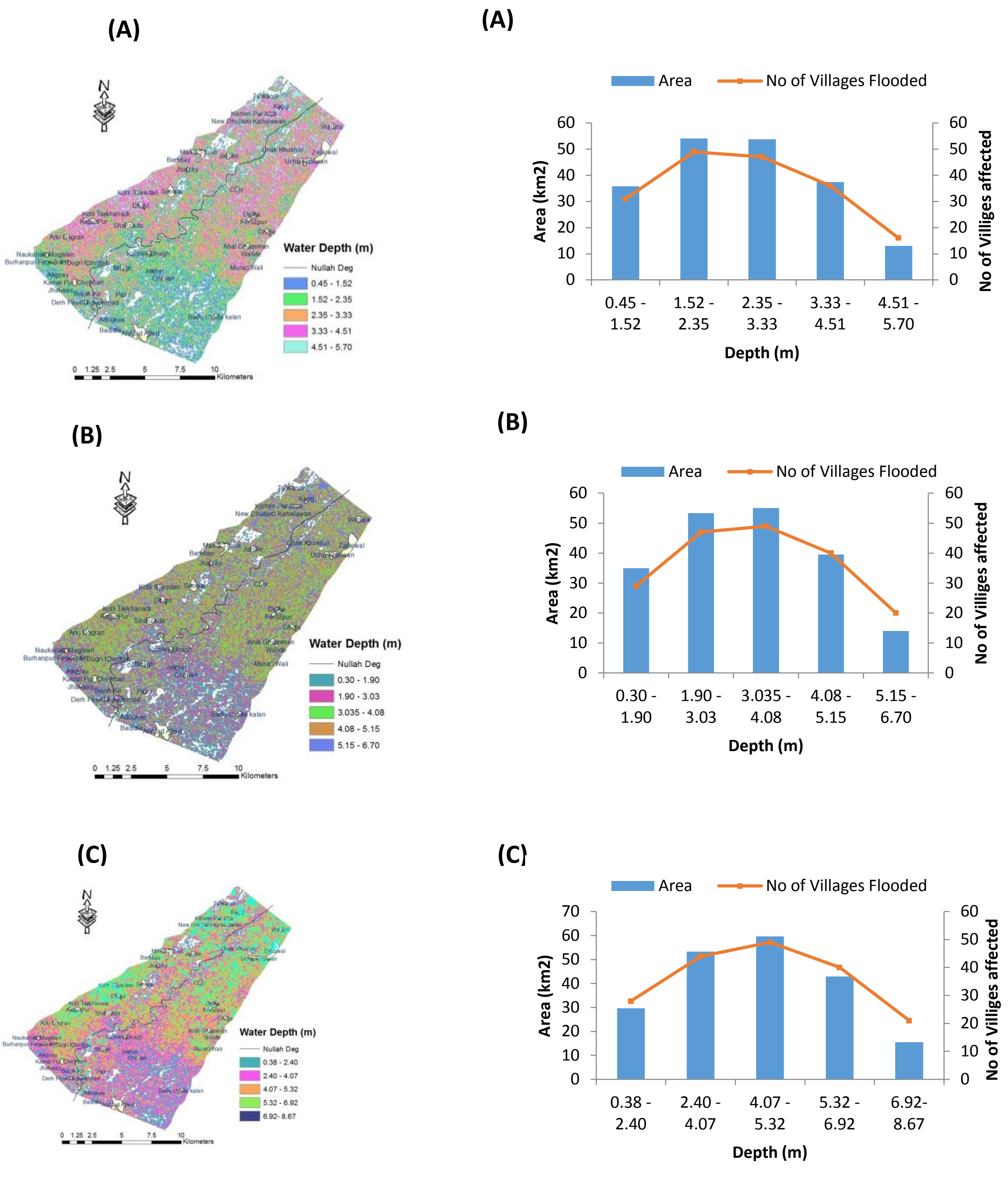

Figure 3 Flood inundation maps and affected area at different retun periods (A) 10 Years (B) 25 years (C) 50 years

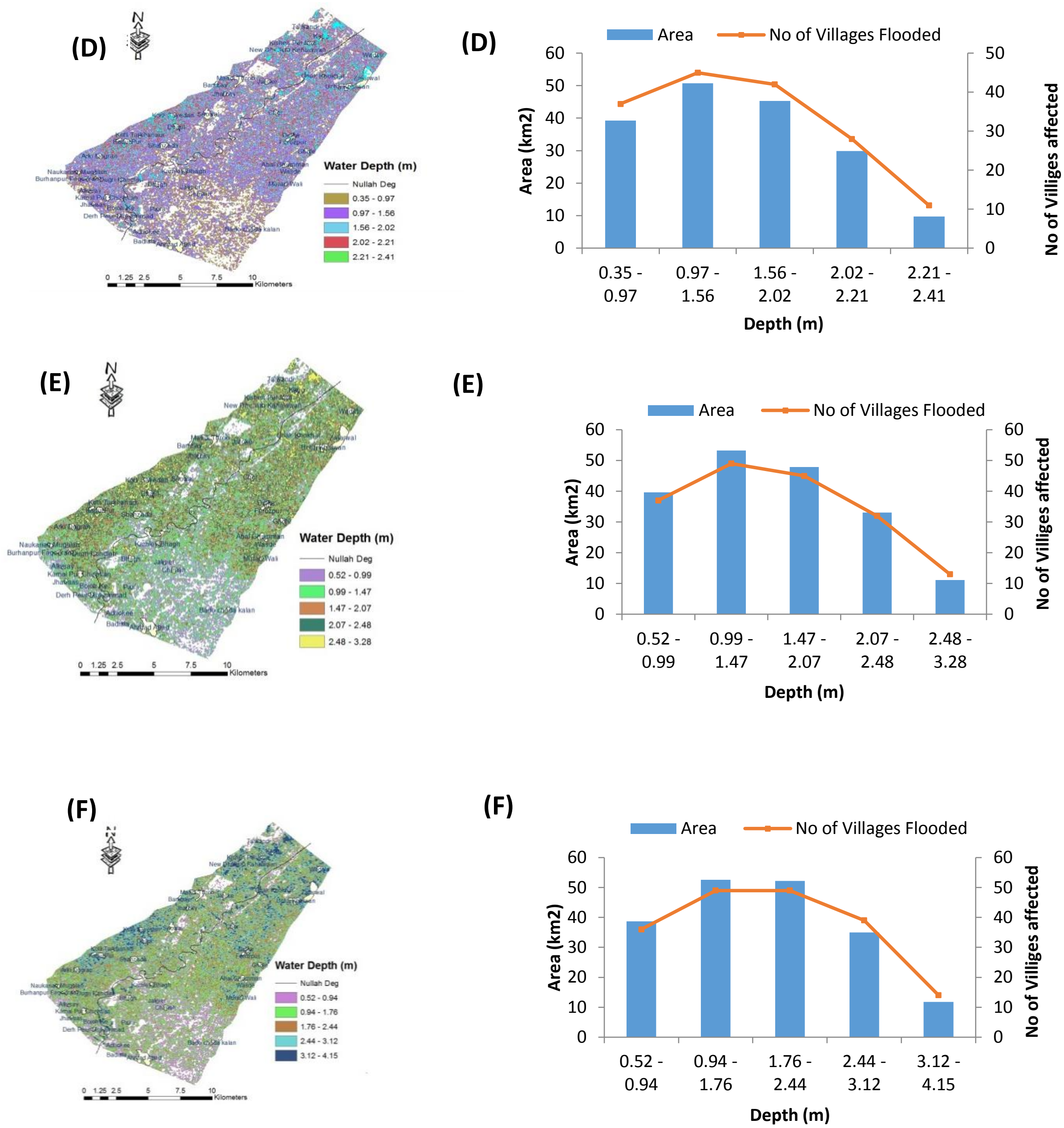

Figure 4 Flood inundation maps and affected area at different retun periods (D) 100 Years (E) 200 years (F) 1000 years

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