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Rising Groundwater Table Problem at Nuri Archeological Site – Sudan: Causes and Potential Dewatering

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Solutions



Royal Kushite Cemetery @ Nuri



The Nuri Royal Cemetery is burial place of the royal families of the second Kushite Dynasty

A total of 73 tombs of Kushite kings and their female folks (queens, princes, and daughters) exist on the site.

The Nuri site was designated as a world heritage site by the UNESCO in 2003 .





Groundwater Table Rise at Nuri Site



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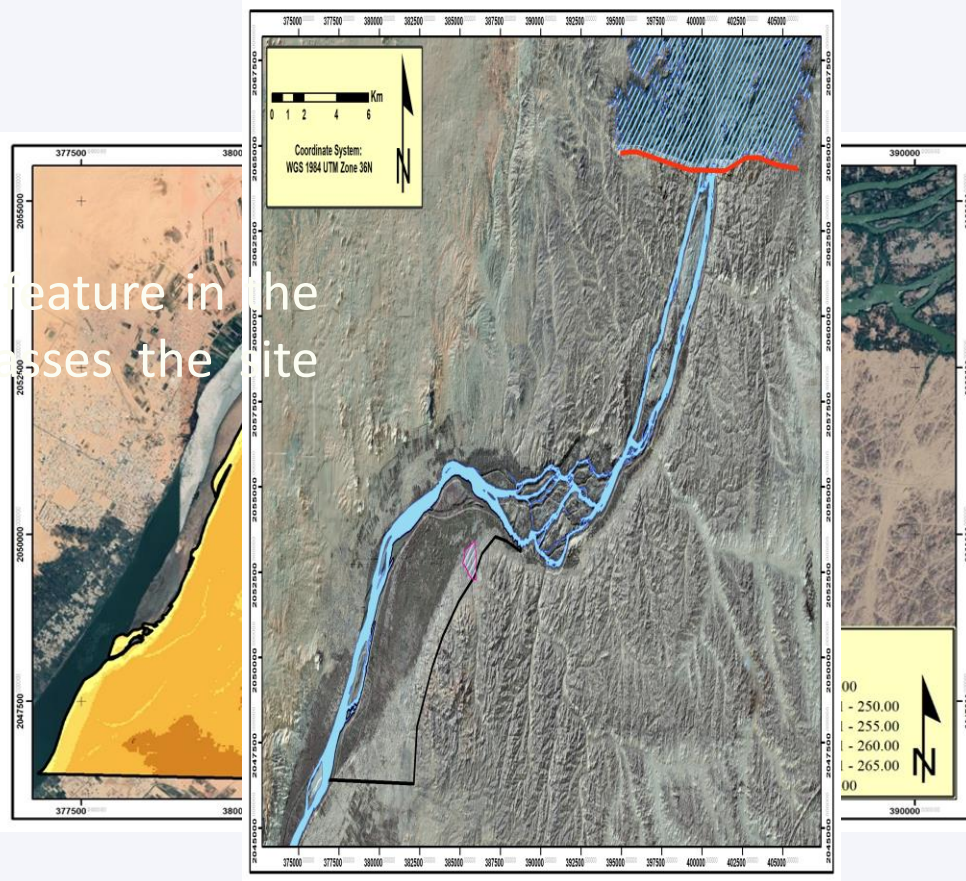
- Archaeological reported a continuous trend of groundwater table rise in the burial chambers of the Nuri archaeological site.
- Under water archaeological [excavations](#) were used to explore the Nuri Site.

The Nu15 tomb was found to be inundated with water reportedly to have been continuously rising.



The area is generally flat with higher elevation of more than 270 m.a.s.l. in the eastern part where some hills consisting of Nubian sandstone formation and basement complex rise above the ground.

Majority of the study area has an elevation between 245 and 260 m.a.s.l., with an average gradient towards the Nile.



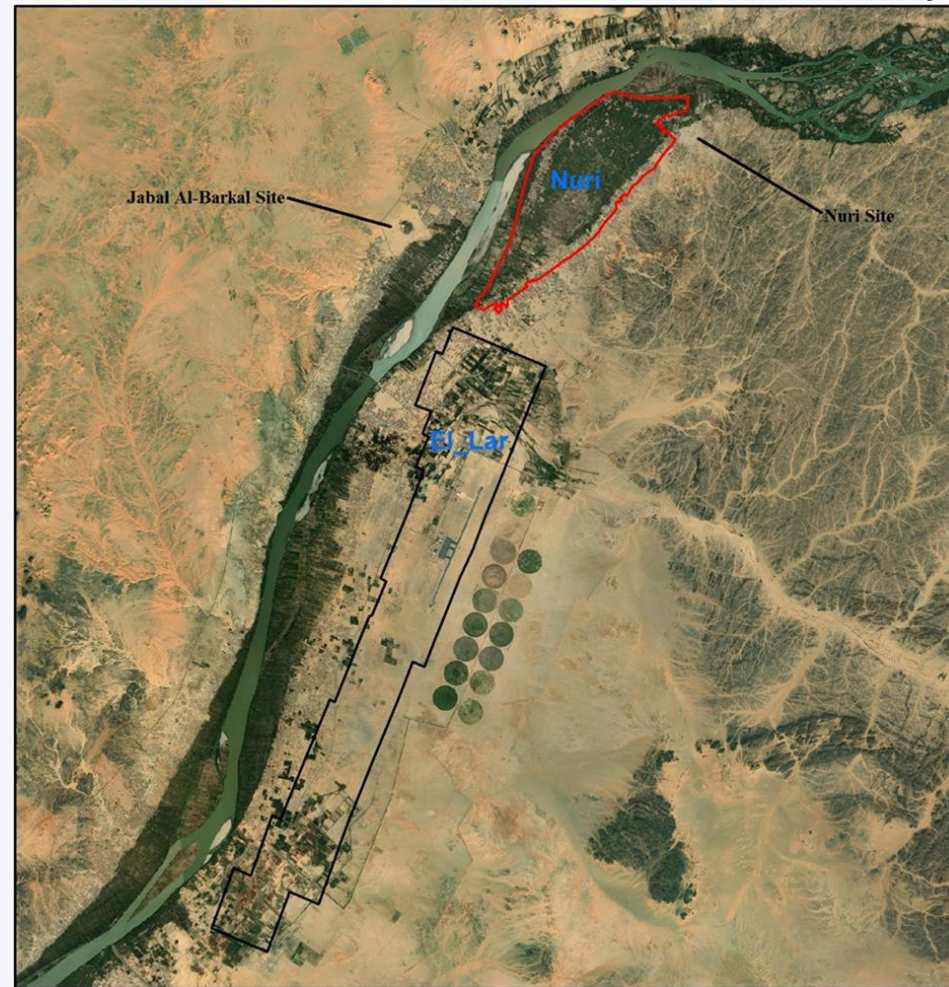


Human Activities



Irrigated agriculture is the main livelihood activity in the area with Nile being the main source of irrigation.

While independent small scale holders irrigation developments using groundwater do exist, the dominant agricultural developments in the area are Nuri (2100 Ha - 1917) and ElLar(840 Ha) Agricultural Projects.





In 2014 electricity was introduced and the diesel pumps were replaced by electrical pumps

Observations show an excess supply of irrigation water of about 5.0 MCM/year (25%) and that the project's irrigation drainage system is not operational

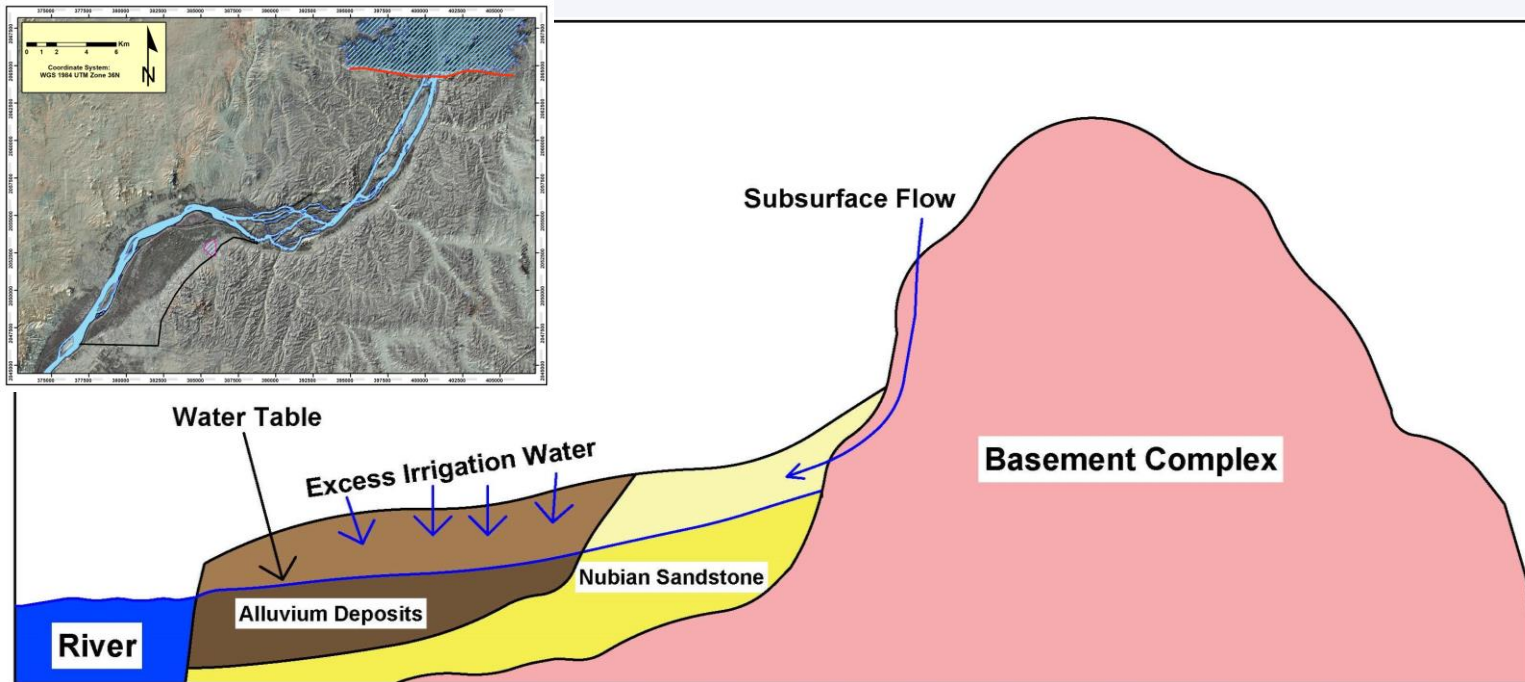
Stakeholders complained about the rising groundwater levels and the damage it has caused to homes



Aquifer Conceptual Model

The project area features a shallow unconfined aquifer on the left bank of the River Nile. Recharge to the shallow unconfined aquifer occur from three sources:

1. Replenishment from the River Nile
2. Infiltration of excess irrigation water
3. Infiltration of surface runoff / Subsurface flow from basement complex

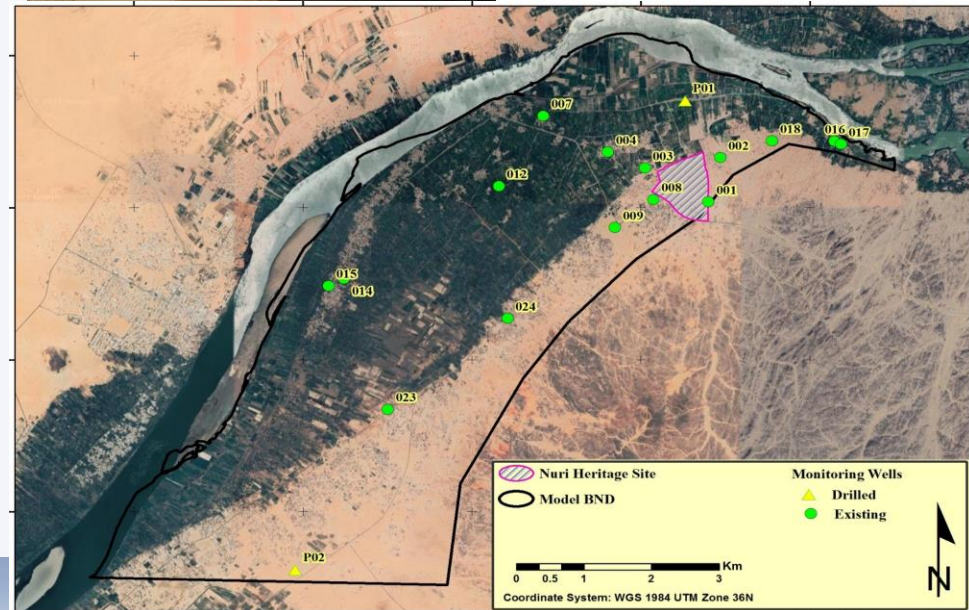




Establishing a Groundwater Monitoring System



- A monitoring system comprised of 17 existing open shaft wells and two specially drilled wells (boreholes) was established.
- Monthly groundwater level measurements were effectively started as of April 2022 with partial measurements since December 202.
- The measurement frequency was increased to twice per month during the rainy season (August/September).
- Measurements were made using a groundwater level indicator. (**With Community Support**)
- Daily River Stage Data were obtained from the MIWR – Sudan

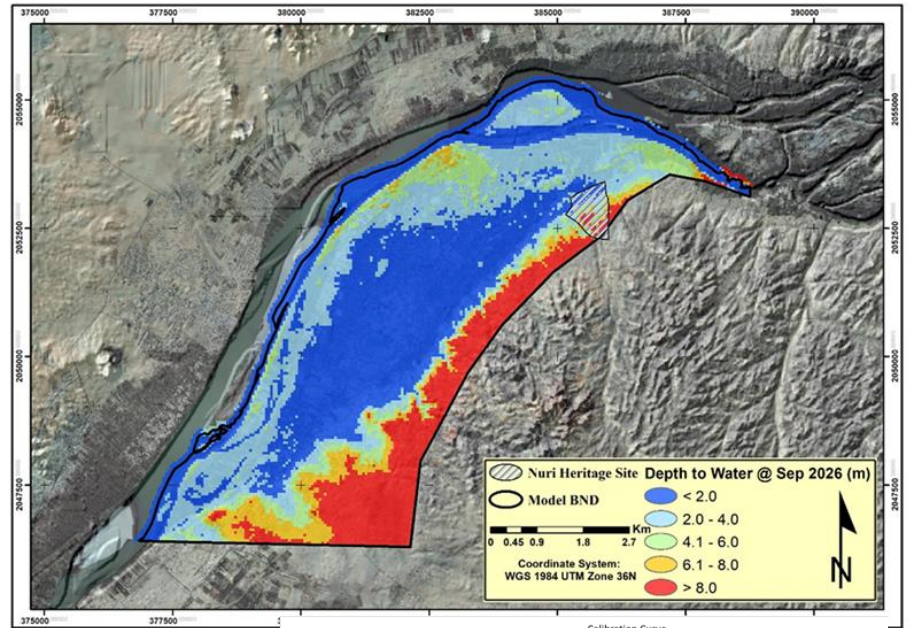




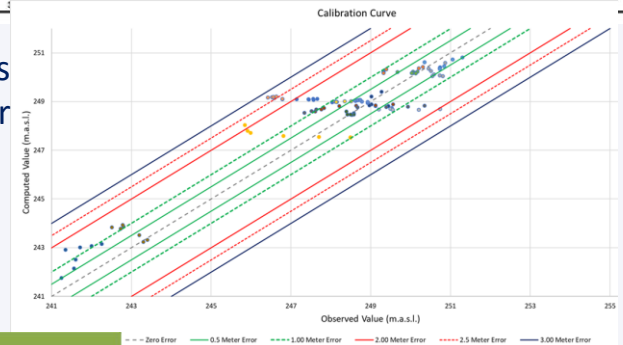
Numerical Model Simulation Results



1. The groundwater level will continue to rise and with average rates varying from 0.10m/year to 0.6 m/year, & about 0.2 m/year. @ Nuri site
2. Depth to water is projected to be less than two meters in about 30% of model area by the end of 2026.
3. the water table elevation @ Nuri Heritage Site is not expected to reach higher than 252 m.a.sl.



112 readings were used for calibration Purposes.

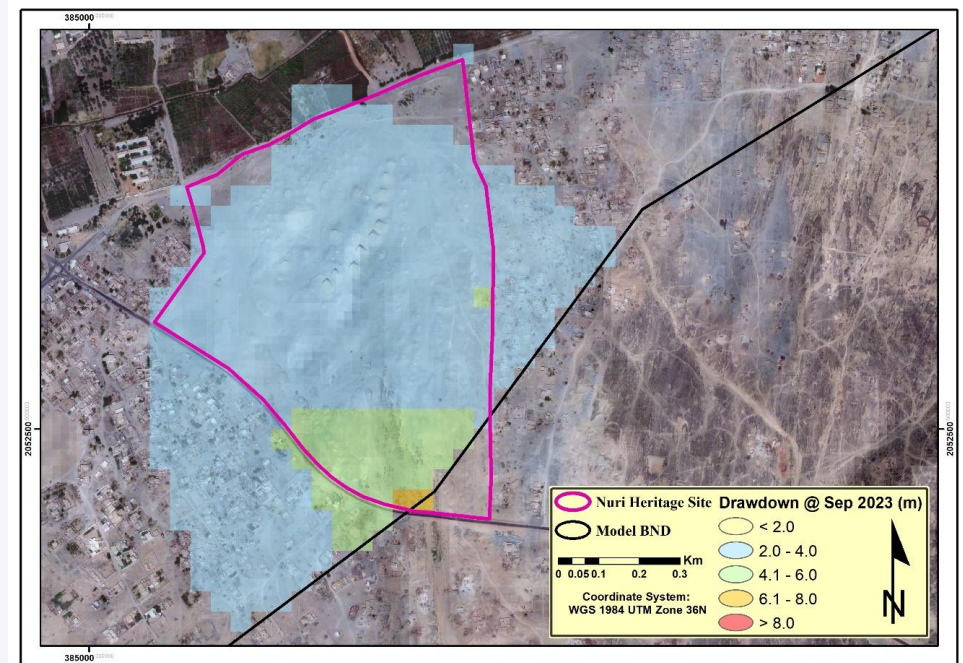


Parameter	Data
Number of Cells	80,000
Model Area	43.2 Km ²
No. Inactive cells	1,7294
No. Active cells	62,706



Proposed Remedial Action

Remedial action will entail the dewatering of excess recharge water and routing it through the natural surface drainage network to the river or diverting the water for irrigation in the Nuri project. A system of seven wells 15 -20 meter to be powered by solar energy was designed



Simulations of the impact of the dewatering system has shown that operation of the dewatering pumps at a rate of 200 m³/day can reverse the groundwater table rise within one month of operations and that the continuous operation of the system is bound to reduce the water table by meters within the whole of the archaeological site.



Summary Remarks & Recommendations



- A unified regional approach that involve all stakeholders to solve the water table rise problem in the Nuri area is needed.
- Engaging the stakeholders to raise awareness about the groundwater rise problem and its potential harmful impacts as a step towards enlisting the community participation in abating this problem is needed. (Improving irrigation efficiency, rehabilitation of the project irrigation drainage network)
- Encourage local farmers to use groundwater for irrigation instead of pumping from the River Nile in an effort to reverse the existing pattern of groundwater recharge by increasing abstraction and reducing surface irrigation losses.
- Introduction of punitive management measures aiming to reduce irrigation water losses (cost of electricity)





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**THANK
YOU!**