



## Conservation of Bani and Johad concurrently: A lost vision

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### Abstract

In the semi-arid region of Rajasthan, thorny forests locally known as *bani* are commonly found in close proximity of almost every village. Within these areas, low-lying depressions called *johad* are formed, which collect rainwater during the rainy season. The *johad* and *bani* are under threats due to anthropogenic activities. The present study discusses the factors contributing to decline in *johad* and *bani* and its implication on groundwater. The two villages each from Churu and Jhunjhunu districts are selected for the study. It is observed that the stored water in *johads* is vital for daily use, especially for livestock and other domestic purposes. However, with the advent of electrification, accessing groundwater has become easier, leading to a reduced reliance on *johads* by the local community. Meanwhile, the growing population has driven up water demand, further exacerbating the over-exploitation of groundwater for agriculture uses. Additionally, the construction of homes along rainwater flow paths obstructs the natural movement of water to the *johads*, contributing to their ongoing decline. *Johads* not only provide essential water for human use but also play a critical role in recharging groundwater reserves. Similarly, *bani* also facilitates the groundwater recharge and the coverage area is continuously declining due to encroachment for the construction of houses and farming. Given their importance, the restoration of *johad* and *bani* is crucial to prevent the rapid depletion of groundwater resources in the region.

## 1. Introduction

The water scarcity in the arid and semi-arid regions of Rajasthan are attributed to climatic conditions such as low rainfall and extreme temperature. The innovation and water management techniques by the community helps in surviving water scarce conditions (Dadhich and Shaban, 2020). The traditional water conservation structures are known by different names across India. Specifically, in Thar desert the traditional rainwater storage are commonly known as *Khadin*, *Kund*, *Johad*, *Talabs*, *Beri*, *Baoli* etc. (Bhattacharya, 2015). *Johads* are earthen dams used for the conservation of rainwater and commonly found in Rajasthan, Haryana, Punjab and western Uttar Pradesh. Main purpose is to channel the rain water to the dug-out area for storage. It is a traditional rainwater harvesting practice followed by centuries. It recharges shallow aquifers, check soil erosion and increase water availability for the livestock. In Alwar district of Rajasthan the

construction of 8600 *johads* is facilitated since 1985 to enhance the availability of water resources (Hussain et al., 2014). *Bani* is grassland or thorny forested land owned by State Forest Department and mainly found close to villages (Fig. 1). Environmental exploitation by human beings is forbidden in the territory of the *bani* since centuries (Gold and Gujar, 1989). The community allocate the land for *bani* and *johads* to conserve environment in ancient times. It was not use for agricultural activities and housing by the community till few decades back. The tradition was followed by the future generations and it becomes a part of culture. Apart from tradition, *bani* and *johad* plays an important role in conservation of environment. In recent times, incidents of fires at the edges of forest are continuously increasing and attributed to anthropogenic activities such as grazing and collection of non-timber products (Krishna and Reddy, 2012). These grasslands are under threat of anthropogenic activities and government is taking initiatives to preserve these unique ecosystems of Thar desert (Islam and Rahmani, 2011).

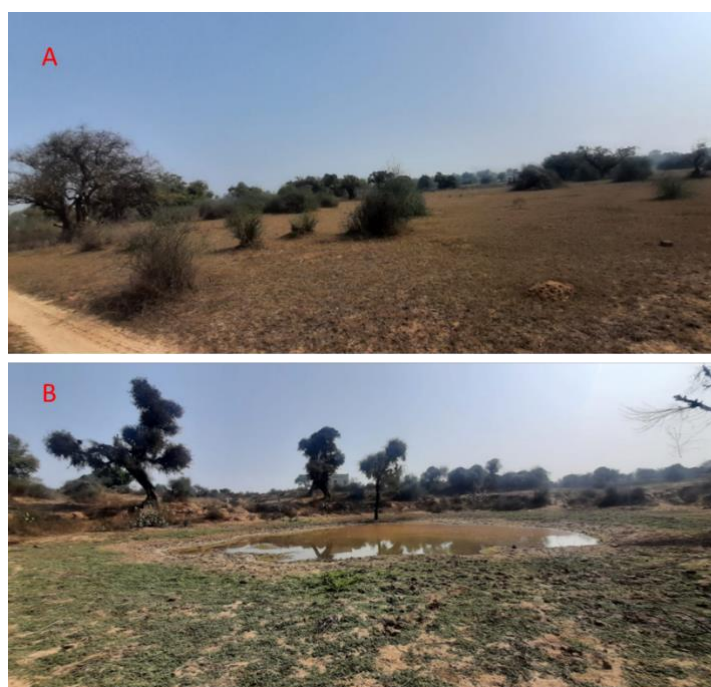


Fig 1. The photographs of A) *Bani* B) *Johad* from semi-arid of Rajasthan, India

*Johads* are majorly found at the heart of *bani* in the districts of Churu and Jhunjhunu Rajasthan. The major factors influencing the water holding capacity of *johads* are catchment area, climatic conditions and anthropogenic activities. The climatic conditions such as rainfall patterns and temperature significantly influence the water retaining capacity of *johads*. The frequent rainfall fills *johads* often however, the longer interval between consecutive rainfall leads to drying up or evaporation of water. In higher temperature regions the probability of water evaporation is more than the wetter region. The catchment area of *johad* is also an important factor and larger the catchment area higher amount of water it holds. In recent times, alongside traditional knowledge of rainwater harvesting structures, geographical factors have also become important for their preservation, contributing to the socio-economic development of the community. (Everard, 2015). For current study, the co-occurrence of *bani* and *johad* from Churu and Jhunjhunu districts are discussed in relation to their sustainability. No study has been carried to understand the co-

existence of the *bani* and *johads* using normalized difference vegetation index (NDVI). The main objectives of the study are to assess the present-day scenario of *bani* and *johads* under the influence of developmental activities such as agricultural activities and construction of built-up. Two types of *johads* i.e. one dried up and second still holding water are selected for the study to understand the possible factors influencing the water retain capacity. The study would be helpful for the policy makers in the conservation of the unique ecosystems of water scare region of India.

## 2. Study area

The selected *johads* and *bani* falls in the Churu and Jhunjhunu Districts of Rajasthan. All the *johads* are observed within the periphery of *bani*'s in the study area. The annual rainfall is ~650 mm and falls in the semi-arid region. Major soil type is sandy/desert soil suggesting the coarser grain size of soil in the region. The main vegetation of *bani* are shrubs such as Jaal (*Salvadora oleoides*) and Kair (*Capparis decidua*). However, in the agricultural fields the Khejri (*Prosopis cineraria*) locally known as Jaati are observed. The field survey was carried out in the month of February, 2025. For the current study, four villages are selected from Churu and Jhunjhunu districts of Rajasthan as shown in Fig. 2. Two villages from each district i.e. Churu (Noohand and Kazi ka Bass) and from Jhunjhunu (Rayla and Bass Mamraj) are selected. Two *johads* i.e. one is dried up and one is filled with water are identified from each Noohand and Rayla villages.

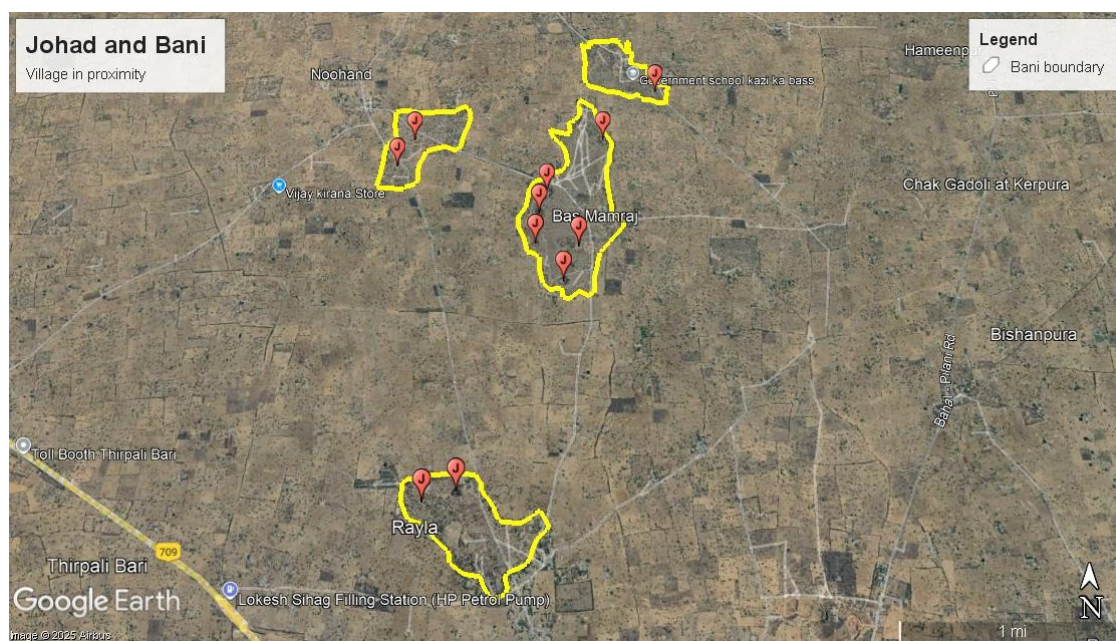


Fig 2. The google earth map showing the locations of Johad (J) and boundary of Bani (yellow line)

## 3. Co-Occurrence of *Bani* and *Johad*

In ancient times, the lack of electricity restricted the extensive withdrawal of groundwater. The electrification of wells results in over exploitation of groundwater for agricultural and domestic purposes. The withdrawal of groundwater for the agricultural activities is approximately

10-20 times higher than industrial and domestic purposes (Srivastava et al., 2025). The groundwater meets the demand of 50% urban and 90% rural population in Rajasthan (CGWB, 2022). The groundwater is overexploited greater than 100% in majority of districts (India-WRIS, 2020) and for Jhunjhunu district it is 165% (Reddy, 2010). The overexploitation of groundwater results in decline its level, causing wells to dry up over time. The decline in availability demands sustainable allocation of water to meet the current and future demands. The expansion of canal network in the arid regions of Rajasthan is also recommended to meet the water demand (Singh and Kumar, 2015). The allocation should be sustainable in terms of social, economic and environmental factors (Chowdhury and Das, 2024). Thus, the decline in groundwater demands the conservation of rainwater to meet the demand for domestic and livestock purposes.

Two main problems *johads* are facing are the degradation in water quality and the decline in the quantity of rainwater stored. A *bani* is a rangeland vegetated of native herbs and shrubs falling in the semi-arid and arid region. The catchment's encroachment and loss of native vegetation is disturbing the efficiency of rainwater harvesting leading to decline in quantity of water storage. The restoration of natural vegetation prevents the soil erosion and land degradation (Stavi et al., 2020; Mganga et al., 2022). With the advent of electrification, accessing groundwater has become easier, leading to a reduced reliance on *johads* by the local community. Meanwhile, the growing population has driven up water demand, further exacerbating the over-exploitation of groundwater for agriculture uses. The decline in water availability leads to desertification and land degradation. Jhunjhunu district of Rajasthan once flourished with agricultural fields is approaching desertification (ISRO, 2018). Desert-like conditions, such as a lack of trees, lead to higher evaporation rates, making it difficult to retain water in dry regions (Cui et al., 2022; Liu et al., 2020). The conservation of *bani*, thorny forest is also important and needs attention. Apart from decline in quantity of stored water in *johads*, the plastic waste from the nearby village is also contaminating the water stored in the *johads*. Thus, the human intrusion not only impacting the quantity of water it is also influencing the quality of water.

The deterioration of quality and quantity of water storage result in ecological degradation and desertification. *Johads* play a vital role in recharging groundwater; however, insufficient rainwater storage in them contributes to the depletion of groundwater levels. The lack of water availability decreases the moisture content and promotes the soil erosion (Moragoda et al., 2022). The enhanced soil erosion increases the silting of *johads* and decreases the water retention capacity. The artificial desertification disturbs the soil biodiversity (Guerra et al., 2020) and the ecological diversity in terms of both flora and fauna (Coban et al., 2022). The community living near the *bani* often cuts down trees for house construction, leading to a loss of vegetation cover. This deforestation contributes to the development of desert-like conditions. Thus, the vegetation of *bani* is increasingly affected by both tree removal and the declining availability of water. The conservation policies should focus on the conservation of both *bani* and *johad* concurrently. Both features should be treated as a single identity. The fauna diversity is continuously declining in Thar desert due to habitat loss, fragmentation and hunting (Sharma et al., 2013). The conservation of thorny forest would preserve the fauna and flora. The community aware about the importance and its short-term usefulness helps in maintaining the structures. The change in behaviour of the community regarding the maintenance of the rainwater harvesting is utmost for the sustainability (Singh, 2018). The lack of awareness about the importance of these structures is one of the main reasons for decline (Sharma et al., 2023).



## 4. Results

### 4.1. Village Rayla, Jhunjhunu, Rajasthan

The *bani* of village Rayala falls in Jhunjhunu district of Rajasthan. Two *johads* were found in the *bani* during the field survey. The locations of *johads* are marked as A and B in the Fig. 3 and the slope direction is denoted by arrow. The *johads* are located at a distance of approximately 300 m from each other. One *johad* (A) is found to be dry, while the other (B) is filled with water at the same time. The catchment area of *johad* A is comparatively smaller than that of *johad* B. A larger catchment area allows more rainwater to flow into the *johad*, resulting in better water retention for a longer duration. It indicates the protection of catchment area i.e. *bani* is important and necessary measures should be taken to prevent any disturbance to it. The rainwater flow path should be saved from the anthropogenic activities such as construction of road or houses. The grass and thorny forest reduce soil erosion and prevent the accumulation in the *johad*. The construction activities in the *bani* loosen the soil and enhance erosion. In the past the extraction of mud from *johads* for the house construction also deepens the *johad*. Thus, in recent times the frequent removal of mud from *johad* is recommended to maintain the water storage efficiency of *johads*.



Fig 3. Google earth map showing the locations of *johads* A) Dried *johad* B) Water filled *johad*

#### 4.2. Village Noohand, Churu, Rajasthan

The *bani* of village Noohand, Churu district has been more extensively encroached upon by residential construction than the *bani* in Rayla. A newly constructed *johad* in the *bani*, intended for rainwater storage, is found to be dry (Fig. 4). However, the older *johad* was still filled with rainwater. The dry and water-filled *johad* are depicting the role of catchments conditions on water availability. The newly constructed *johad* (A) is in vicinity of village and many new houses are built in recent years hindering the water path. The second *johad* (B) is away from the village located in almost at the centre of the *bani* covering the maximum catchment of thorny forest. The distance between constructed and old *johad* is ~300m. Future initiatives must be more strategically planned, taking into account the influence of anthropogenic activities. The application of remote sensing is needed for the identification of sites for better sustainability of *johads*. The mapping of sites considering land use, land cover, slope, and soil types are important factors to increase the efficiency of rainwater harvesting structures (Rawat et al., 2023). However, the identification of locations for the storage of rainwater is very difficult even using the modern tools such as satellite images (Kolekar et al., 2021). In the past, the anthropogenic activities were not prominent as compared to recent times hence the feasibility of the traditional *johad* were mostly efficient in earlier time. In current scenario under the burden of population explosion and anthropogenic activities the use of only traditional knowledge is not sufficient. However, the sites chosen by our ancestors for the rainwater harvesting are still useful after restoration.



Fig 4. Google earth map showing A) newly constructed *johad* and B) older *johad*

## 5. Normalized Difference Vegetation Index (NDVI)

NDVI change detection maps were generated to evaluate the variation in vegetation cover. The Google Earth Engine was used to compute and generate the NDVI maps. NDVI values were computed for the years 2001, 2015 and 2024 using LANDSAT 7 and 8 imageries (Fig. 5). Satellite images for LANDSAT 7 and 8 are consisted of Collection 2 and Tier 1 atmospherically corrected surface reflectance with 30 metres of resolution are used. For LANDSAT 8, the spectral bands namely Band 5 Near-Infrared (0.85 - 0.88  $\mu\text{m}$ ) and Band 4 Red (0.64 - 0.67  $\mu\text{m}$ ) are used. For LANDSAT 7, Band 4 NIR (0.77 - 0.90  $\mu\text{m}$ ) and Band 3 Red (0.63 - 0.69  $\mu\text{m}$ ) are used for the NDVI computation using equation 1. The area of interest (AOI) delineating the selected *Banis* were defined for carrying out the NDVI analysis.

$$\text{NDVI} = \frac{(\text{NIR} - \text{RED})}{(\text{NIR} + \text{RED})} \quad \text{--- Equation 1}$$

where, NIR represent reflectance near infrared light and RED is reflectance in red light for respective satellite images.

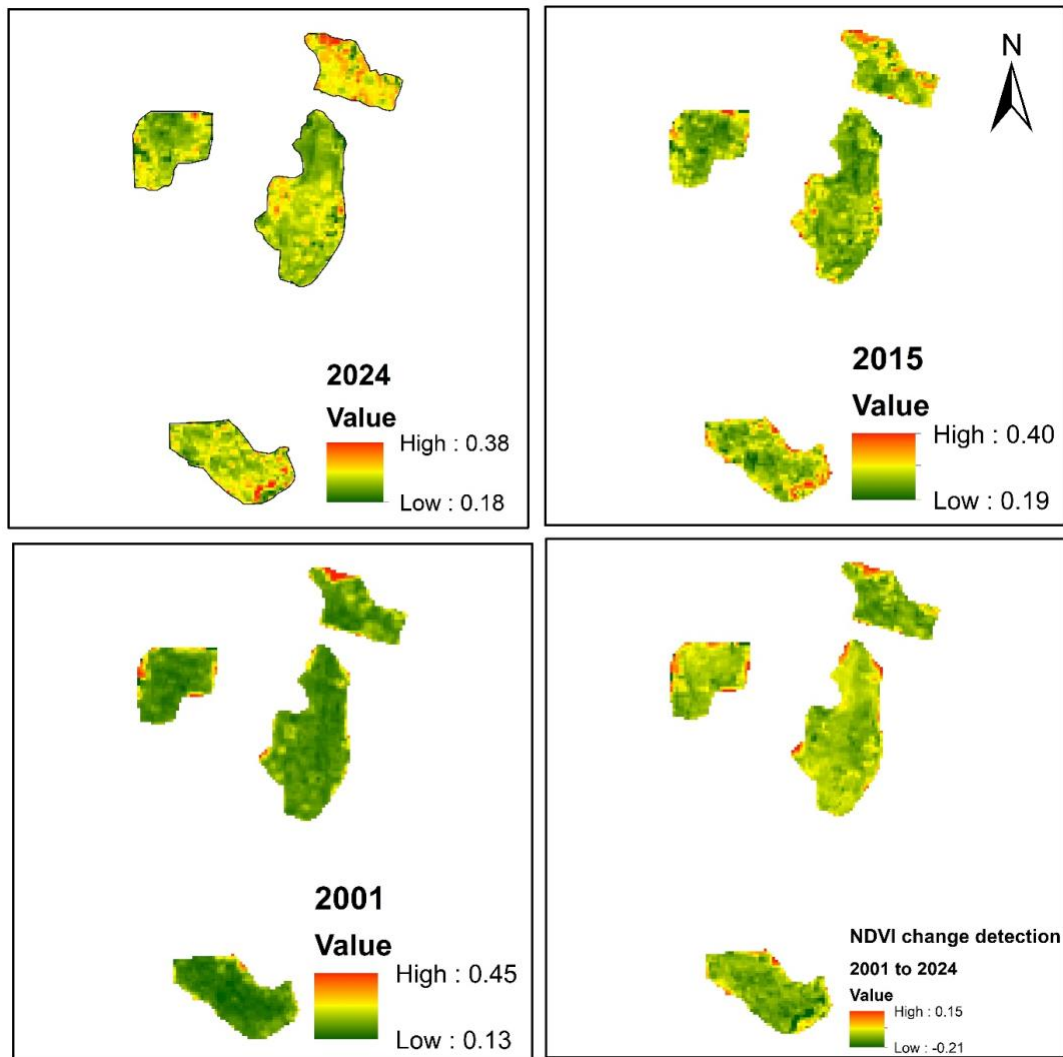


Fig. 5 NDVI maps for the years of 2001, 2015 and 2024 along with NDVI change detection (2001-2024)

The highest NDVI values show a decreasing trend from 2001 to 2024 i.e. 0.45, 0.40 and 0.38 for 2001, 2015 and 2024 respectively suggesting the decline in vegetation cover. The imagery shows more pronounced decline along the edges of *Bani*'s compared to central areas suggesting the peripheral encroachment into the forest. Additionally, the vegetation cover within the *Bani* is natural and no agricultural activities occur there, so the seasonal variations in NDVI due to sowing and harvesting are irrelevant for current study. The Normalized Difference Water Index (NDWI) is commonly used to assess and map of surface water resources. The spatial extent of *Johads* is very small approximately ranges from 50-100 m while the satellite imagery has a spatial resolution of 30 meters only. It indicates each *Johad* is represented by 2-3 pixels only, making it difficult to accurately measure the changes in surface water at such a fine scale. Hence, the use of NDWI is not feasible for the current study.

## 6. Recommendations and scope

*Johads* were traditionally constructed close to central locations within the *bani*. The forested land of the *bani* prevents soil erosion and the rainwater falling within its catchment is used to collected in the *johads*. It minimizes contamination from agricultural fields and village areas. In recent times, encroachment for agriculture and house construction has disrupted the watershed of the *johads*. It allows the contaminated runoff from farms and settlements to enter in *johads*. Furthermore, the community now tends to treat the *bani* and *johad* as separate entities. Similarly, State Forest Department schemes also address the conservation of *bani* and *johad* independently, overlooking their ecological interdependence and the importance of their co-existence.

The study is preliminary in nature and further studies focusing on the assessment of water quality parameters should be carried out. The land use and land cover mapping would reveal the factors influencing the water storage efficiency of *johad* and the decline in *bani* coverage. Thus, future studies should be carried to assess the temporal and spatial changes in land use and land cover of *bani* and *johad*. Extensive field surveys should be carried out to assess and enhance the community involvement in restoration activities. The study only highlights the problems related to *bani* and *johad*. A detailed study to explore effective mitigation strategies for the restoration of *bani* and *johad* ecosystems.

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