International Journal of Civil Engineering
(IJCE)
ISSN (P): 2278–9987; ISSN (E): 2278–9995
Vol. 15, Issue 2, Jul–Dec 2026; 1–16

International Academy of Science, Engineering and Technology
Connecting Researchers; Nurturing Innovations

STONE AND WATER: THE KAKATIYA LEGACY OF LIFE IN THE DRY LANDS MASTERS OF WATER: WHEN RULERS BUILT LAKES THAT STILL STAND TODAY SUSTAINABLE WATER ARCHITECTURE OF THE KAKATIYA DYNASTY (12TH-14TH CENTURY CE)

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ABSTRACT

The Kakatiya dynasty (12th - 14th centuries CE) was one of the medieval Indian dynasties that developed the most advanced indigenous water resource management system in the semi-arid regions of Telangana, India, by way of unique hydraulic engineering and ecological design of water systems. This paper discusses the integral concept of water architecture created by Kakatiya rulers and their successors and includes such types of water resources as tanks, artificial lakes, chain-tank systems, bunds, sluices, irrigation canals, stepwells, and urban water structures. Special attention is paid to the functions of these water resources in rainwater harvesting, groundwater recharge, sustainable agriculture, flood regulation, conservation of biological diversity, and community-based governance. Examples of the most famous man-made hydraulic structures, such as Ramappa Lake, Pakhal Lake, Laknavaram Lake, and Ghanpur Tank, are presented to prove the importance of the ecological wisdom of ancient inhabitants of Telangana in creating the water infrastructure. Moreover, the research analyses the importance of the Kakatiya practices from the standpoint of modern approaches, such as IWRM, climate adaptation, and sustainable development.

KEYWORDS: *Kakatiya Dynasty; Traditional Water Management; Hydraulic Engineering; Chain Tank System; Rainwater Harvesting; Sustainable Water Governance; Integrated Water Resources Management; Telangana Heritage; Climate Resilience; Indigenous Ecological Knowledge.*

Article History

Received: *25 Sep 2026* | ***Revised:*** *28 Sep 2026* | ***Accepted:*** *02 Sep 2026*

INTRODUCTION

Water has continued to play a critical role in human civilization since its establishment, having a bearing on settlement, agriculture, economy, and culture [1]. For India, water has always been viewed as a critical resource, along with being a sacred element that formed an integral part of social practices, religion, and governance. Hence, building and maintaining water infrastructure was an important task of the state, especially those facing climatic constraints.

Deccan Plateau is a region that faces a semi-arid climate, monsoonal dependence, and a lack of perennial river systems. It has led to the formulation of effective methods for harvesting and utilizing rainwater. Unlike other river civilizations, rulers of medieval Telangana have formulated a decentralized system of hydraulics that could store and distribute rainwater effectively. Kakatiya dynasty (12th -14th century CE) in Telangana stands out as a prime example of

indigenous innovation in medieval India.

A dynasty from the Telugu region ruling from Warangal from about 1000 - 1323 CE, they also excelled culturally, militarily, and architecturally under rulers like Ganapatideva, Rudrama Devi, and Prataparudra II. [3].

Figure 1: Kakati Devi in the Kakatiya Dynasty, Representing the Kakatiya Rulers[5]

Besides temple architecture and accomplishments, they have constructed large tanks, reservoirs, canals, sluices, and irrigation channels, making Telangana's dry terrain fertile agricultural land [2] [4]. Their decentralized system of water management facilitated community engagement in construction, maintenance, and fair distribution of resources, besides enhancing the recharge of groundwater resources and improving climate resilience [4].

The decline of these ancient systems has been caused by changes in administration, lack of community involvement, and dependence on irrigation schemes. All of these factors have contributed to the degradation of water recharging and water security in the region [4]. Efforts made for the revival of these ancient structures in initiatives like Mission Kakatiya have faced several issues.

This research examines the Kakatiya hydraulic system as a combined engineering, ecological, and societal-administrative system, while studying the creation of these various structures, like tanks, bunds, sluices, canals, and reservoirs, how they operated, and their relevance to sustainable water management, climate adaptation, and the current concept of IWRM.

HISTORICAL APPROACH

The current investigation utilizes a qualitative historical research design to critically analyze the water management strategies and hydraulic engineering practices of the Kakatiya dynasty (12th-14th century CE). As the inquiry into this subject is historical in nature, the investigation depends solely on secondary data and is pursued with the aid of descriptive and comparative analytical methods that investigate the history, architecture, and implications of water conservation works of the Kakatiyas [5]. The present study neither attempts to produce primary data through field surveys nor interviews, but it synthesizes all information from varied academic and historical records.

The primary sources of information have been peer-reviewed journal articles that are listed in Google Scholar, books, book chapters, archaeological studies, epigraphic data, government papers, and international heritage papers [6]. There has been a specific focus on literature dealing with the history of the Kakatiyas, medieval-era hydraulic engineering, traditional irrigation methods, temple architecture, environmental history, and water resource management. Historical inscriptions and epigraphic data have been referred to to confirm the details related to the construction, patronage, maintenance, and management of reservoirs, tanks, canals, and other hydraulic infrastructures. Furthermore, the UNESCO designation for Kakatiya heritage sites and government programs like Mission Kakatiya have been taken into consideration for validating the importance of these historical systems in modern times.

The study will be based on the use of a multi-disciplinary framework that combines theories of history, architecture, archeology, environmental studies, and water resources management. A descriptive methodology will be used to analyze the physical aspects of Kakatiya irrigation systems. In addition, a comparative method will be used to determine the relevance of these structures to modern ideas of sustainability, climate adaptation, and recharge of groundwater reserves [7]. Triangulation of evidence through various scholarly literature will increase the reliability of the findings and help interpret the Kakatiya hydraulic system as a sustainable environmental planning and community-based governance model.

HISTORICAL BACKGROUND OF THE KAKATIYA DYNASTY

The Kakatiya dynasty became one of the most prominent dynasties of South India and left its deep imprint on the history of the eastern Deccan during the period from the eleventh to the fourteenth centuries CE. While the exact roots of the dynasty are still disputed by historians, the evidence provided by inscriptions proves that at first, the Kakatiya dynasty was a vassal of the Rashtrakuta dynasty and then of the Western Chalukyas before acquiring political independence. Some versions of the origin of the dynasty link its name to Kakatipura; other versions connect the origin of the name with the local cult of the deity Kakati Devi [5].

Early rulers like Gundaya and Ereya ruled as feudatories of the Rashtrakutas in the late ninth and early tenth centuries. The Kakatiya dynasty continued after the end of Rashtrakuta rule by becoming feudatories of the Western Chalukyas, where rulers like Beta I, Prola I, Beta II, and Prola II started expanding their territorial dominance in the Hanumakonda region. The most significant event took place in the year 1158 CE when Rudradeva (Prataparudra I) claimed independence following the downfall of Western Chalukya rule, thereby forming the Kakatiya dynasty with Hanumakonda, and later Orugallu (modern Warangal) as their capital [3] [5].

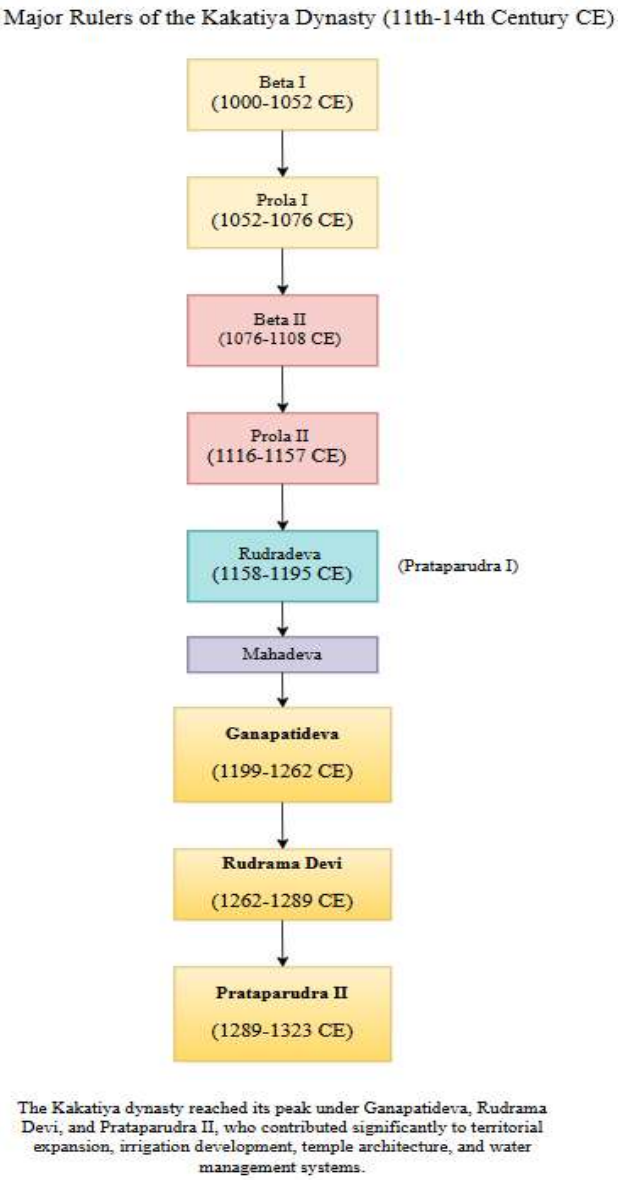

Figure 1: Genealogical Succession of Major Rulers of the Kakatiya Dynasty (11th - 14th Century CE).

The greatest period of this dynasty from the political and administrative points of view was under the rule of Ganapatideva (1199 – 1262 CE), Rudrama Devi (1262 – 1289 CE), and Prataparudra II (1289 - 1323 CE) [5]. The rulers of this time greatly expanded the kingdom, covering a large area which today forms the states of Telangana and Andhra Pradesh, while also making many contributions to the advancement of the administration, agriculture, commerce, architecture of temples, sculpture, literature, and the construction of irrigation systems [14]. Historical sources show that the system of decentralization of power was used by the Kakatiya dynasty, thus allowing for efficient management of their ever-growing territory. It was because of these factors that a formerly semi-arid region was developed into a prosperous agricultural region.

The political transformation of the Kakatiya dynasty signifies a slow process of movement from being regional feudatories to becoming one of the most significant ruling entities in medieval South India. Even though it is known that the ancestry of the Kakatiya family can be traced back to the ninth century, it is only after 1163 AD that their kingdom emerged independently under Rudradeva (Prataparudra I). Initially ruling from Hanumakonda (Anumakonda), the dynasty

subsequently established Orugallu (present-day Warangal) as its fortified capital, transforming it into an important administrative, commercial, and cultural centre of the Telugu-speaking region [8] [3].

The dynasty reached its greatest territorial and administrative expansion under Ganapatideva (1199 - 1262 CE), who consolidated the upland Telangana region and extended Kakatiya authority from the Godavari and Krishna river basins to the eastern coast and parts of Kanchipuram. His reign was distinguished not only by military success but also by extensive investments in urban development, temple construction, reservoirs, and irrigation infrastructure. Rudramadevi, who ruled between 1262 and 1289 CE, succeeded Ganapatideva to become one of the few queens in the history of medieval India. While faced with resistance from other neighboring kingdoms and some segments of nobility, she worked on improving the administrative system of the kingdom, strengthening the defenses of Warangal, and continuing the focus of her dynasty on developing agriculture and irrigation. The last of the great rulers was Prataparudra II, who ruled from 1289 to 1323 CE and inherited a rich but politically unstable kingdom. Even though Prataparudra II defended his kingdom against many invasions, the fall of Warangal in 1323 CE to the Delhi Sultanate marked the end of Kakatiya rule [8] [5].

The location of Telangana greatly impacted the politics of the Kakatiya state. It had an elevated plateau of the Deccan region, rocky terrain, seasonal rivers, and erratic monsoon rains, even though it had fertile soil suitable for agriculture.

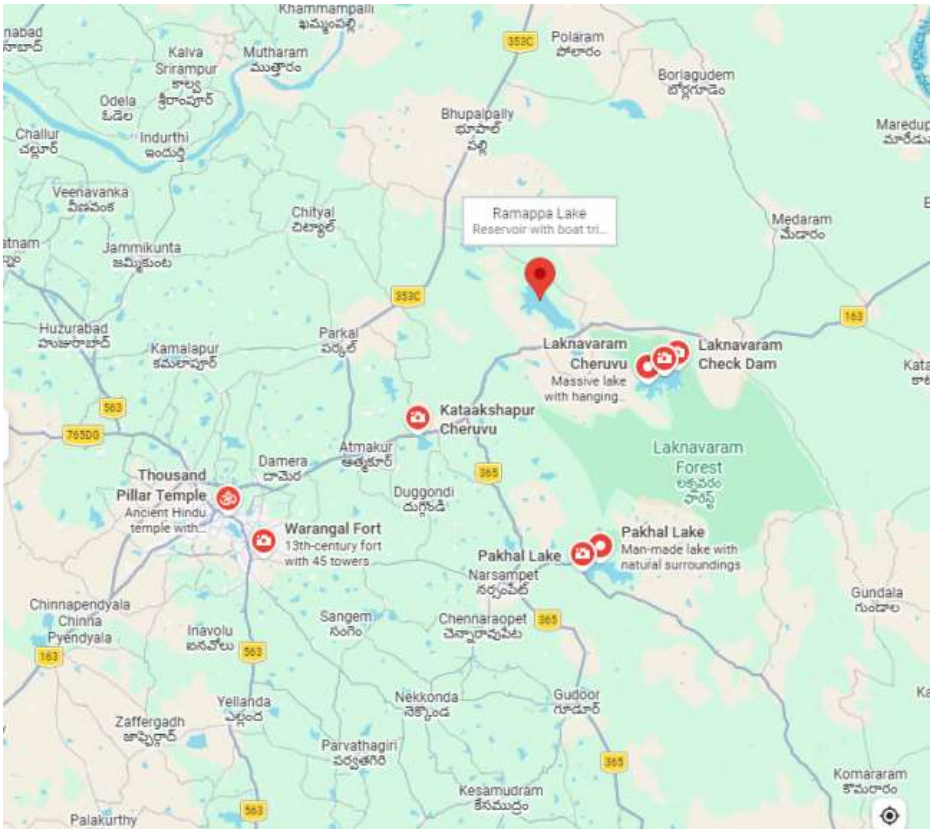

Figure 3: Location map of Telangana showing Warangal, Ramappa Lake, Pakhal Lake, and Laknavaram Lake.

Figure 4: Traditional Irrigation Tanks Built During the Kakatiya Era in Telangana [5].

Agricultural productivity was consequently dependent on efficient rainwater collection and storage, rather than constant irrigation through rivers. Given this understanding of the environmental limitations, the Kakatiya kings devised a system of governance in which the establishment of cities, temples, and reservoirs was combined, creating a network of tanks, canals, and bunds that turned the arid environment into a productive agricultural region. Therefore, the historical evolution of the Kakatiya dynasty is inseparable from its unique strategy of water management.

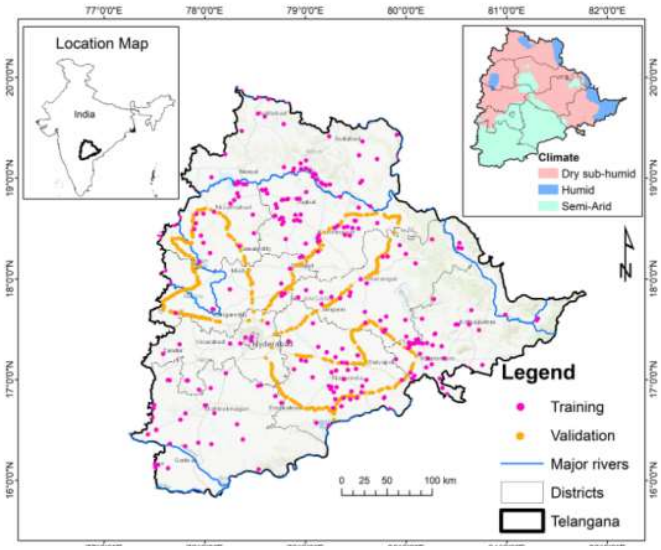

Figure 5: Map of Telangana Showing Major Rivers, Districts, and Water Bodies [16]

WATER ARCHITECTURE AND ENGINEERING INNOVATIONS

Tanks and Artificial Reservoirs

The artificial reservoirs were an essential component of the Kakatiya water management system, helping them make the best use of the rainfall runoff from the monsoons to collect and distribute water efficiently in the semi-arid areas of Telangana. These reservoirs were constructed by making use of the natural valley present between granite hill ranges, thereby allowing the construction of irrigation systems, recharge of groundwater, provision of water for domestic use, and agricultural development while decreasing reliance on perennial rivers.

Figure 6: Irrigation Systems during the Kakatiya Region [9]

Notable among these isPakhal Lake, which was built in 1213 CE during the reign of Ganapatideva and turned the forest hills into productive farmland, maintaining at the same time the ecological balance. Ramappa Lake was also built in 1213 CE under RecherlaRudra; the construction is notable for its highly advanced hydraulic engineering design, featuring an enormous earthen dam, strategically placed hills, and linking to the Ramappa temple and irrigation system. In addition, Laknavaram Lake served as a crucial storage lake for the interlinked tank system, whereas the Bayyaram Tank was irrigating huge areas of farmland despite being neglected subsequently. Likewise, the Ghanpur Tank (GanapaSamudram) was built under Rudramadevi, reflecting the development of the irrigation system in a decentralized fashion among the local feudatories [10].

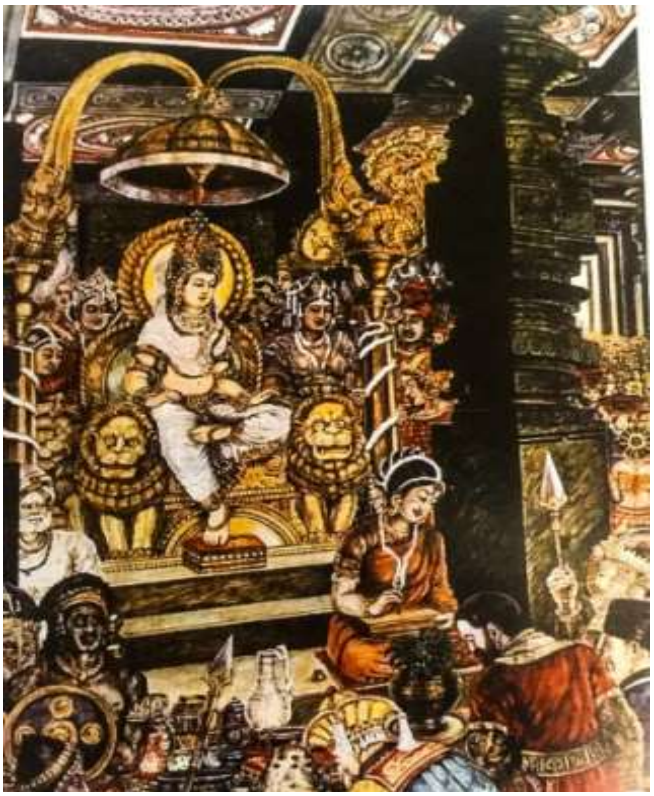

Figure 7: An Art Depiction of the Court of Rani Rudramadevi of the Kakatiya Dynasty [5]

Individual Case Studies of Major Kakatiya Lakes

Badrakali Lake

Badrakali Lake, located near the historic Badrakali Temple in Warangal, represents the integration of sacred spaces and hydraulic landscapes in Kakatiya urban planning. Although the lake has undergone modifications over different historical periods, its association with the Kakatiya cultural landscape demonstrates the importance of water bodies in supporting religious activities, settlement growth, and ecological balance. The lake functioned as a water storage system while also contributing to groundwater recharge and maintaining the environmental character of the surrounding region. The presence of temples, settlements, and water reservoirs illustrates the Kakatiya principle of combining cultural, social, and ecological functions within a single landscape.

Figure 8: Badrakali Lake and Temple Landscape.

Ramappa Lake

Ramappa Lake, constructed in 1213 CE during the reign of Ganapatideva by his military commander RecherlaRudra, is one of the finest examples of Kakatiya hydraulic engineering. The lake was created by constructing an earthen embankment across natural valleys between hill ranges, allowing efficient storage of monsoon runoff. Its design supported agricultural irrigation, groundwater recharge, and ecological sustainability. The reservoir demonstrates the Kakatiya understanding of landscape-based engineering, where natural terrain was modified to create long-lasting water storage systems.

Figure 2: Ramapa Temple and Lake.

Laknavaram Lake

Laknavaram Lake is one of the significant reservoirs developed during the Kakatiya period and represents their advanced understanding of water storage in semi-arid regions. Located among forested hills, the lake utilizes natural topography for efficient water retention. The reservoir consists of multiple interconnected storage areas supported by bunds and channels, reflecting the principles of decentralized water management. Laknavaram Lake contributed to irrigation, groundwater recharge, and ecosystem conservation by maintaining water availability during dry seasons.

Figure 3: Laknavaram Lake.

Chain Tank System

A distinctive feature of Kakatiya hydraulic planning was the GolusuKattuCheruvulu or chain tank system, in which multiple reservoirs were hydraulically interconnected across a watershed. Water released from an upper reservoir flowed sequentially into downstream tanks through gravity-fed canals, maximizing storage efficiency and minimizing wastage. This cascading arrangement ensured that excess runoff from one tank replenished subsequent reservoirs while simultaneously reducing flood intensity during heavy monsoon rainfall.

Figure 11: Golusucattucheruvulu [11]

Apart from irrigation, the integrated chain-tanks played an important role in groundwater recharge through the slow percolation of water into the adjoining aquifers and ensured their sustainability in dry months. While previous rulers of Choda dynasty had started constructing parts of the chain-tank system, it was the Kakatiya dynasty that developed and institutionalized the practice of constructing chain tanks throughout Telangana. The watershed technique employed by the Kakatiyas is not very different from the current practice of watershed management.

Bund Construction

The longevity of Kakatiya reservoirs was ensured by the use of scientifically engineered bunds using local soils, compacting earth, stone pitching, and gradient slopes. Vulnerable parts were strengthened by granite boulders, while stone revetment was used for the protection of the embankments from waves and surface erosion. Compaction not only made bunds stronger but also prevented seepage as well.

Figure 12: Ramappa Lake Showing the Water Storage [12]

The careful design of sluice gates, spillways, and overflow channels controlled the release of water from the reservoirs and thus avoided any flooding that could lead to the collapse of the embankments. The successful operation of the majority of the Kakatiya bunds even today, despite the passage of more than seven centuries, is evidence of the efficacy of native engineering skills, choice of materials, and maintenance systems.

Fort Moats and Urban Water Systems

Water Management techniques were not only applied in agricultural practices but were used in urban design and defensive architecture as well. Warangal, the capital city, designed the city layout so that the water structures were incorporated in the fort. The Warangal Fort used the surrounding moats both for protection from enemy attack and for storage and drainage facilities. The water structures not only provided physical protection from the attack but also controlled stormwater flows in the city area.

Urban hydraulic engineering entailed the strategic placement of reservoirs, ponds, channels, and other structures required for meeting the needs of the population and providing environmental balance. It can be seen how the water structures have been integrated with the spatial structure of the city. For example, in the case of Ghanpur Fort, the strategically located ponds provided a water supply for both the population and military units.

These combinations of efences, water storage, and drainage, together with town settlement, show the versatile nature of the Kakatiya water management system. The Kakatiya town networks indicate an integrated approach to engineering in which water functions: agricultural, ecological, social, and tactical. The Kakatiya urban planning with its hydraulic management system gives a remarkable indication of how to manage an urban water system in a more integrated, ecological, social, and even strategic way.

TEMPLES, WATER, AND SACRED ECOLOGY

This civilization fostered a relationship that is unique for its time amongst temples, water resources, communities, and ecology. The Kakatiya civilization (12^{th} to 14^{th} centuries CE) made the temple not just a place of worship but a cultural, social, economic, and ecological center in relation to its surroundings, such as the tanks, reservoirs, fields, and villages. The architectural philosophy of this civilization is evident through its focus on the development of the town, Temple, and Tank.

Creation of lakes around temples denoted both spiritual worthiness and wise resource management. As per Kakatiya civilization's belief system, the construction of tanks came to be regarded as one of the important deeds of social virtue because it aided agriculture, communal well-being, and environmental equilibrium. Creation of the elaborate system of lakes by rulers like Ganapatideva and Rudramadevi promoted collective participation whereby communities worked on sustaining the water resources and the cultural landscape surrounding them.

The Ramappa Temple in Palampet is one of the best examples of this ecological relationship. Built in the year 1213 CE on the orders of the general of King Ganapatideva, RecherlaRudra, the temple complex was built along with the Ramappa Lake, thus creating a hydraulic and religious landscape. The function of the lake was to provide irrigation services for farming purposes, while improving the ecological surroundings of the temple complex.

Figure 13: Kakatiya Rudreshwara Temple [13]

Further, in the context of Warangal, the Badrakali Temple reflects the importance of water in the religious landscape, and the Badrakali Lake became integral to the ecological and religious context of the region. At Pillalamarri, the Nameswara Temple highlights the close interaction between the temple complex and the water resources, wells, and tanks that sustained the community life in its environs.

Figure 14: Sri Erakeswara Temple at Pillalamarri, Exhibiting the Stepped Diamond Architectural [5]

This was the notion of spiritual ecology whereby sanctity and reverence for nature provided a framework for the safeguarding of natural resources within a collective society. Water reservoirs were regarded as symbols of purity, wealth, and longevity, and temples were the focal points of the entire social order.

Figure 4: Sculptural Detailing of Kakatiya Temple[5]

The cultural landscape of the Kakatiyas hence displays a concept of sacrosanct conservation in which the ecological, social, and religious spheres were interwoven, enabling the local communities to protect their resources through communal efforts. These examples have significant implications for today's concerns about sustainable development and cultural preservation.

SUSTAINABILITY PRINCIPLES IN THE KAKATIYA WATER SYSTEM

The Kakatiya water management is an exemplary case in the history of sustainable governance of natural resources, which integrated the understanding of ecology, hydraulic engineering, agronomic efficiency, and participation of communities. The system was established in the thirteenth and fourteenth centuries in the semi-arid region of the Deccan plateau in Telangana State. Rainwater harvesting, decentralized water storage, and efficient distribution were the key features of the water management system.

Rainwater harvesting was at the base of Kakatiya's hydraulic planning. Reservoirs, including artificial lakes like Pakhal Lake, Ramappa Lake, Laknavaram Lake, and village tanks, ensured the collection of monsoon runoff from hills and undulating terrain [15]. Water harvesting in the reservoirs minimized the loss of runoff, ensured the availability of water during dry periods, and facilitated agricultural development. The chain tank system, referred to as GolusuKattuCheruvulu by local people, worked on the principle of interconnected storage reservoirs wherein excess water from one tank flowed into downstream reservoirs.

Conservation of groundwater was one more important aspect of engineering by the Kakatiyas. Tanks, beds, feeders, and zones of percolation helped to infiltrate water and recharge groundwater resources while preserving ecological balance. A combination of surface and underground water helped to implement the concepts that are similar to modern IWRM (Integrated Water Resource Management) when water resources are managed as a whole entity, taking into account socio-economic and environmental aspects.

One more advantage of the Kakatiya technology is its high level of climate resilience. Use of decentralized tanks instead of large reservoirs made people less vulnerable to droughts and irregularity of rainfall. It also provided storage diversity, which ensured uninterrupted access to water for agriculture, animal husbandry, and household use. Moreover, wetlands that surrounded the reservoirs allowed biodiversity of plants, fish, and other aquatic life in reservoirs, as well as birds and forests in wildlife sanctuaries, for example, Pakhal Lake Sanctuary.

Agriculture continued to be the main beneficiary of such an efficient water system. Irrigation tanks converted dry plateau areas into fertile farmlands owing to a steady supply of water for cultivation purposes. The Kakatiya system was highly efficient in terms of resource management and governance because it followed the local approach involving villages in maintaining, cleaning, and regulating the water distribution process. Maintenance procedures such as bunding, sluice control, desilting, and canal maintenance show the importance of continuity in such a sustainable water system.

The Kakatiya water model is quite similar to modern Sustainable Development Goals such as SDG 6 (Clean Water and Sanitation), SDG 2 (Zero Hunger), SDG 11 (Sustainable Communities), and SDG 13 (Climate Action). This system proves that many aspects of the past can help us in managing water in a sustainable manner today.

DISCUSSION: LESSONS FOR MODERN WATER GOVERNANCE

Indeed, the Kakatiya water management scheme offers valuable lessons to modern water governance in India because it showed how decentralized, ecologically integrated, and community-based hydraulic planning could be done successfully. Unlike the modern water systems in the urban areas that rely extensively on centralized facilities, the Kakatiya system created an integrated system of tanks, reservoirs, canals, and recharge schemes that would manage rainfall variation, agricultural demand, and ecological sustainability.

It is important to draw parallels between the Kakatiya water management system and the present-day water management in India. The key difference is that the Kakatiya system relied on widespread storage through many tanks, while urban development in modern India has led to the loss of water bodies through encroachment, land use change, and poor maintenance. As a result, the destruction of tanks in cities has become one of the causes of increased flooding as natural drainage channels and zones of water accumulation are now lacking. Besides, overexploitation of groundwater sources has led to the lowering of the water table in numerous places, while the Kakatiya tanks served as natural recharge schemes.

Figure 5: Remains of Warangal Fort and Kakatiya Kirti Thorana [5]

These challenges have been exacerbated by climate change through erratic rainfall patterns, high levels of precipitation, and persistent drought. The example set by Kakatiya highlights the importance of having climate-adaptive infrastructure in which several small and medium reservoirs within landscapes offer resilience to hydrological uncertainties. Lessons could be learned by modern water governance in the way of revitalizing tank networks, protecting catchment areas, and combining the traditional system with science-based watershed management.

Governments could learn from the decentralized governance of Kakatiya, along with community participation and institutions that facilitate maintenance. Engineers could learn from historical wisdom regarding hydrological connectivity, sustainable designs, and nature-based solutions for modern infrastructure. Urban planners could consider water bodies as important ecological elements instead of vacant lands fit for development. Conservationists could use the lessons of Kakatiya to advocate for the restoration of cultural landscapes that integrate biodiversity, heritage, and water security.

Studies related to traditional water systems of India have highlighted that indigenous hydraulic practices are adaptive mechanisms evolved after centuries of experience in dealing with the environment. It implies that the Kakatiya model has much to teach to meet the IWRM and Sustainable Development Goals objectives. Integration of history with modern engineering is one way to move towards sustainable water management in India.

CONCLUSION

The Kakatiya water management system is one of the best examples of ancient hydraulic management that integrates technology, ecology, agriculture, and community involvement. By creating tanks, reservoirs, interlinked chain systems, sluices, canals, and other water structures, the Kakatiyas created a sustainable water system that was applicable to the climatic characteristics of the Telangana plateau.

The present research will contribute to a better understanding of the Kakatiya hydraulic landscape in terms of not only an old infrastructure but also a whole water management practice that relies on sustainability, decentralization, and adaptation to the environment.

The relevance of the Kakatiya system for the present and future will emerge when it is able to guide contemporary developments such as IWRM, NbS, and climate-resilient plans. Conservation and scientific inquiry of these traditional systems can enhance sustainable water use practices while safeguarding the cultural identity. The Kakatiya water system, thus, represents an exemplary model that continues to inspire how humanity could harness human intelligence, knowledge of nature, and the commitment to communal welfare to develop sustainable water resources for the well-being of generations to come.

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