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Institutional Report

National Institute of Advanced Studies (NIAS)

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The National Institute of Advanced Studies (NIAS) was established in 1988 by late Shri J.R.D. Tata to develop interdisciplinary approaches to address societal issues and carry out multi-disciplinary research in the area of humanities, social science, science and engineering as well as in conflict and security studies. The studies related to cultural landscapes through remote sensing, proto-historic megaliths, ancient mining and metallurgy are carried out to conserve our geo-heritage and improve the livelihood of local communities. The challenges faced by India for developing energy resources and protecting the environment. The areas such as optima electricity mix, air pollution, climate negotiations, etc. are being addressed. Effective communication about national hazards can prepare communities to face cyclones, floods, etc. An effective disaster communication strategy is being developed,

Keywords: Cultural Landscape; Megaliths; Archaeometallurgy, Energy and Environment, Science Communication

Introduction

The National Institute of Advanced Studies (NIAS) was established in 1988 at the initiative of late Shri J.R.D. Tata to address complex challenges faced by society by conducting multi-disciplinary and inter-disciplinary research in areas of humanities, social sciences, science and engineering, as well as conflict and security studies. It has been recognized as the 'Institute of the Exceptional Repute,' by the NITI Aayog in 2019.

The programs related to the 'Heritage, Science and Society,' 'Energy and Environment,' and 'Science Communications'have components related to geosciences. A brief description of these activities has been provided.

Heritage, Science and Society

Cultural Landscape Studies

Humans have modified their local environment continuously to suit themselves. Although these changes may disappear within a few generations when observed at ground-level, they often leave lasting scars that can be observed from the vantage of satellites. Geospatial technologies have proved cost-effective and time-efficient in locating sites of archaeological interest and in documenting the landscape around them. Large swathes of land can be surveyed using remote sensing images to identify archaeological features that may be invisible or difficult to notice at ground level.

Given India's vast size and rich cultural heritage, many sites remain *undocumented*. In some cases,such sites have been identified in early surveys (19th century onward). However, their existence has been omitted from the documentary record as they are camouflaged by landcover, for instance, unprotected mounds around Nalanda (Rajani, 2016). Similarly, archeological mounds around large Buddhist sites in the Ganga Valley like Bodhgaya and Vikramshila using stereoscopic images and photogrammetric techniques were identified (Rajani and Das, 2018 and Das *et al*., 2019). One of the unique studies was related to analyzing the underground water supply system used in Bengaluru in the 20th century (Suganya and Rajani, 2018). Both early and modern surveys have failed to identify archaeological remains such as the Gulam Ali tomb at Srirangapatna, which were identified using remote sensing data (Gupta *et al*., 2017a).

Coastlines are a very dynamic landscape and

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are affected by morphological processes of both sea and land. A unique method for exploring India's coastline by using Portolan charts (medieval maps made in Europe, used for marine navigation) and historical records together with satellite images has been developed. Such analysis has enabled the identification of seven monuments at Mahabalipuram which constituted the toponym "Seven Pagoda" for the site (Rajani and Kasturirangan, 2012).

Undocumented sites are primarily unprotected, and they face an increased risk of being damaged or destroyed due to the growing demand for land for development. These development activities have the potential to cause permanent damage (directly or indirectly) to heritage embedded in cultural and natural landscapes. Unlike objects of small size that can be moved to museums or other safe places, landscapes must be conserved *in situ*.

One of Tipu Sultan's armories lay on the planned path of doubling the Bengaluru-Mysuru railway line at Srirangapatna, but the project proceeded and then stalled while a decision on the fate of this structure was debated. In addition to the economic impact caused by this delay, the eventual decision to preserve the structure resulted in significant additional cost to move the armory (Gupta *et al*., 2017b).

The city of Agra was once a unique settlement with glorious specimens of architecture, a network of canals, and several river-front gardens. These were recorded in a hand-drawn map of Shahjahani Agra made in 1720 for Raja Jai Singh of Jaipur. Large-scale development activities since the 19th century (laying railway lines, roads, and urban/industrial sprawl) have largely disregarded this cultural landscape. As a result, Agra's monuments (Taj Mahal, Agra Fort, etc.) survive as disconnected islands, while the few riverfront gardens that remain are rapidly deteriorating into obscurity (Suganya and Rajani, 2019).

It has been planned to create a national geospatial database of cultural heritage landscapes through accurate geospatial analysis, characterization and documentation (Gupta *et al*., 2017b). Such information can be easily integrated with auxiliary cultural information specific to locations available from ground survey reports. The results of such an analysis can be used to monitor sites on an ongoing basis and can also be digitally archived and retrieved for future research. As phase-1 studies related 30 sites, selected from World Heritage and tentative sites listed on the UNESCO website, has been initiated. Geospatial documentation of existing monuments, at *Srirangapatana*, Avati, Sirival, Halebidu and Aihole in Karnataka were undertaken using geospatial techniques (Gupta *et al*., 2017a and Das *et al*., 2017).

Studies on Monumental Architecture and Proto-historic Megaliths

Monumental architecture at Hampi and Badami are excellent examples of melding of monuments and landscapes in regions with very different landforms and geology. Hampi and Badami, in northern Karnataka, were capital cities of the Vijayanagara and Chalukya dynasties during the late and early medieval periods, respectively. Both these sites have spectacular landscapes, tumbled granite boulders and inselbergs in Hampi, and sandstones ridges in the Badami region. The monumental architecture of Badami consists of both rock-cut and structural monuments. These are some of the earliest monuments in stone in Southern India. The Vijayanagara empire imported the parallel Dravida tradition of the Tamil region. The site characteristics and landscape and the modification of these to locate monumental architecture are being investigated. These studies range from the location of ancient quarries and arriving at an understanding of stone extraction and processing (Kuppa and Menon, 2018) and the practice of architecture in various periods in history, to the virtual reconstruction of unfinished monuments (Komandur and Menon, 2018).

A large number of megalithic structures are present in the vicinity of the well-known temples of Badami, Pattadakal and Aihole, as well as several lesser-known sites in the valley of the River Malaprabha. The recent discovery of an unreported megalithic site (Menon, 2019, Submitted) consisting of a cluster of nineteen stone circles, located at an Early Chalukyan stone quarry called Motara Maradi near Pattadakal in northern Karnataka, is the result of explorations in this region over the last several years. The stone circles are made of rubble blocks of various sizes, unlike the usual megalithic boulder circles, and five of these circles contain cairns. These may probably be graves of the Early Chalukyan

artisans, rather than protohistoric megaliths. It is necessary to establish the chronology of these megaliths to locate them in the chronological framework of monument-building traditions in the region. Last year, another discovery of explorations in the Malaprabha Valley – of a painted rock shelter, which seems to have been used by megalith-builders as well as Early Chalukyan artisans, was reported (Menon and Padigar, 2018).

These studies – of monumental architecture in the historic as well as preceding protohistoric phases in southern India, are aimed at developing an understanding of knowledge systems existing in the various stages of development of architectural traditions. The techniques developed in this extensive study of the Malaprabha Valley will be applied to other significant sites of monumental architecture in the Indian subcontinent.

Ancient Mining, Metallurgical Extraction, Ores and Geology

A program in the area of ancient mining and history of metallurgical extraction; drawing from studies of ore and geological formations; evidence for old working, slag and other archaeometallurgical debris; use of ore geochemistry and geosciences applications in the understanding of metal extraction and metal technology and characterization of artifacts has been undertaken. Original preliminary studies have been made in terms of identifying old working and slag heaps, from archaeometallurgical investigations and studies on ore and slag geochemistry in various parts of south India for copper smelting, bronze making iron smelting, and old gold mines covering Karnataka, Telangana, Andhra Pradesh and Tamil Nadu (Haricharan *et al*., 2016, Srinivasan, 1997, 1999a, 2016a). Significant studies have also been made in identifying production sites for making crucible steel and related ore sources such as banded iron ores (Srinivasan, 2016b; Srinivasan and Ranganathan, 2013). Some preliminary insights into mining for gold in auriferous quartz reefs in various parts of southern India have also explored. Some of the research has covered the Ingaldhal and Kalyadi copper mining area, the Agnigundala mining area in Andhra Pradesh, north Karnataka and the Hutti-Maski belt, and the Nilgiris (Srinivasan, 2016c). The program has also been concerned about the local communities living as stakeholders in these geologically significant mining areas such as blacksmiths in Telangana, northern Tamil Nadu and north Karnataka. A substantial contribution of the program is in the application of geosciences in understanding metals and materials heritage such as the use of lead isotope geochemistry and lead isotope ratio analysis and trace element analysis to finger-printing metallic artifacts such as south Indian and Chola bronzes and the use of electron microscopy in the study of slags and ores related to ancient metal extraction activities which also through geological insights (Srinivasan, 1999a, 1999b, 2008, 2016d). Another dimension is the exploration of experimental technology to understand the local resources such as ores and clays in the study of the extractive metallurgy and alloy formation related to ferrous and non-ferrous alloys (Srinivasan, 1998, Srinivasan *et al*., 2009). Studies of brass and zinc metallurgy are also underway and will be explored in more detail in the future. In all of these preliminary studies, further support is required in terms of more systematic surveys to explore the ancient mining concerning geological aspects along with excavation, exploration and experimental studies for characterization. The program is also concerned about impacting policy in terms of conserving the geo-heritage and legacy of mining history and local geology and in engaging stakeholders such as local crafts communities to improve their livelihood prospects as well as to be able to conserve better and promote these important but neglected aspects of geo-heritage.

Workshop on Geo-Heritage

A one day workshop was organized at National Institute of Advanced Studies (NIAS), Bangalore, to deliberate upon the current status and existing legislation in India and other countries. It was proposed aiming to find out means and mechanisms to protect and better manage India's geo-heritage through conservation and preservation of our natural heritage. NIAS has had a substantial investment in understanding heritage through various projects on intangible and tangible cultural heritage in India and disseminating information on heritage amongst multiple sections.

The topics discussed included understanding geoheritage as a term, its scope, and exiting practices of conservation practiced within India. The speakers

represented a varied array of professions with decades of experience in geology, and with hands-on experience. The workshop resulted in creating a multiplicity of views and conversations amongst the speakers as well as participants who took part in it, which included discussing the lack of comprehensive measures at present to ensure the conservation of geoheritage in the country. The workshop came to an end on the positive note that steps are being taken across the country by various participants to initiate more such discussions on the need for concrete measures to conserve, protect and disseminate information on geoheritage.

Energy and Environment

The Energy and Environment Program (EEP) research encompasses all forms of commercial energy: coal, hydro, nuclear, gas, and renewables, as well as their environmental and societal implications. The research focus is on the major challenges faced by India in the fields of Energy, Natural Resources, and the Environment. All ongoing research projects are interlinked through the Sustainable Development Goals.

In addition to their research, teaching, institutional responsibilities, and outreach activities, EEP faculty are also engaged in working groups constituted by GOI on critical aspects of National mineral and coal policies. They have also provided vital inputs to GOI on the National Steel Policy and Power Sector reforms. Some of EEP's key recommendations concerning the mineral sector have been incorporated in NITI Aayog's report on "Strategy for New India@75" submitted to the GOI in November 2018, while NIAS recommendations related to the power sector have been incorporated in GOI's proposed amendments to the Electricity Act.

Coal continues to provide fuel for 75% of electricity generation. The coal mining has improved the economy locally; however, it had also affected ecology and the environment. One of the significant issues in the closure of coal mines. The Ministry of Mines has apprised for 583 coal and lignite plans by March 2019. Based on the research finding, policy interactions have been proposed to restore the environment as much as possible.

To advance EEP's goal of "research with relevance," a collaboration with Government departments and agencies and other like-minded organizations have been established in areas like optimal electricity source mix, air pollution, energy sustainability, sustainable transportation strategies, climate negotiations, waste-water treatment, and public health. Policy-focused workshops to bring together key stakeholders to discuss critical subjects like human-environment interactions, and power sector reforms, have been organized.

Science Communication

India being a mosaic of the culture as well as the spatial and geological properties of the environment, understating dynamics of the change happening in both climatic factors and people's responses at the micro-level of the society and reaching information relevant to a specific region is indispensable for reducing the risk during calamities through effective communication. Hence, in the current context of changing climate and unprecedently increasing natural disasters, geospatial technologies are becoming an indispensable tool in the arsenal of the risk communicators. For instance, during the Kerala deluge, 2018, communication of the exact geographical location and their specific need by the people who got isolated using the tools of social media helped the authorities to plan the evacuation activities accurately and the rescue team to conduct operation for saving the lives of people. Furthermore, there is research available to prove that the provision of geographical information can enhance the effectiveness of the warning messages.

The merging points between geospatial technology and science communication for enhancing the effectiveness of awareness creation programs, risk communication, preparing the public to face calamities and mitigation of natural disasters such as flood and cyclone has been undertaken. This research aims to come out with a road map for effective disaster communication specific to the Indian subcontinent.

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