British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

BGS ODA research programme: Concept Note for Amaravati

Background

The British Geological Survey (BGS) focuses on public-good science for the UK government, and international research to understand earth and environmental processes.

Part of our national funding up to 2020 will be directed to Official Development Assistance (ODA) activities and developing partnerships in the UK and overseas with government, academia and civil society in DAC countries that deliver research to underpin the UN Sustainable Development Goals. Promotion of economic development and welfare of the DAC country is its main objective.

Understanding geological processes, and how they can underpin sustainable urbanisation and the resilience of cities to stress, is one of BGS's ODA research themes, and Indian cities will be one of our key focusses, building on other BGS research, in India*.

The ground beneath cities, and why it matters

BGS is at the forefront of national geological surveys in addressing the sustainable use of the ground beneath cities. Our experience and expertise has been gained in the UK (e.g. Glasgow, London), across Europe (leading the SUB-URBAN European Cooperation in Science and Technology (COST) Action, and internationally in Hong Kong, Abu Dhabi and Singapore. In the latter, we have worked with the Singaporean authorities (MND) over the past 3 years to build geological capacity and visualise the storage and aquifer resources beneath the city.

Evidence accumulated by BGS shows that ready access to digital data and knowledge of the urban sub-surface, especially at an early stage, has considerable benefits for practitioners. Crucially, its translation into forms understandable and useable by non-scientists, enables improved decision-making in planning and development, better use of ground beneath cities, and drives innovation.

Tangible economic, social and environmental benefits can then result, and conflicting, harmful and costly uses of the subsurface can be avoided (unforeseen ground conditions are the largest single cause of delay and overspend in construction projects worldwide).

Whilst many Indian cities have improved access to water and sanitation, the pace of urbanisation is daunting; challenges around urban planning, infrastructure, and resource management (e.g. unsustainable reductions in groundwater level) are significant. The urban sub-surface can play a positive role in all of these.

We are seeking opportunities to develop an Indian city as a "lighthouse" for other Indian cities to be inspired by, and follow. Amaravati, as a largely greenfield site, is an ideal candidate. In particular, it provides the opportunity for early intervention of geological knowledge, in decision-making when it can have the greatest potential impact.

As an exemplar Smart City, developed in harmony with its sub-surface, Amaravati should benefit from improvements in: delivery of its infrastructure; liveability for its people from innovative use of its resources, and; stewardship of its environment. It would also lead other Indian cities forward, and as part of a wider regional "urban hub", which BGS will create with others, it would influence city development across southern and SE Asia, and indeed globally.

Why Amaravati?

The sub-surface presents both challenges and opportunities for a city. Neither is routinely taken into account in urban planning. In contrast to all the cities BGS and others have studied around the globe, Amaravati presents a unique and exciting opportunity to address the sub-surface planning 'blind spot', and in particular to;

- acquire and manage digital sub-surface data highly efficiently and effectively for multiple re-use, before, during and after development;
- sensor the sub-surface and monitor it to enable real-time responses; and
- build the geological knowledge and understanding needed to underpin the design and 'liveability' of a modern Smart City of c.3-5m people.

Understanding not just the city but its role and impact in the wider catchment is essential to build robust adaptation strategies and understand the cascade of hazards and outcomes that will occur in response to man's activities.

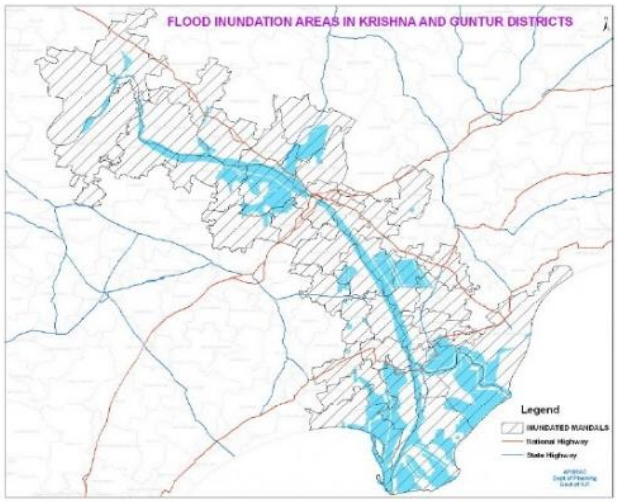
For example, an assessment of the opportunities in terms of water and energy resource will support the use of natural resources (water, heat, space) to augment district cooling and help future-proof the city for increasingly extreme summer temperatures.

Sustainable drainage schemes (SuDs) linked to groundwater will help to manage flooding and improve planning of infrastructure (metro tunnels, sewers, etc.). If built in at an early stage, it can deliver significant cost benefit and informed decision making.

Artists' impression of Amaravati capital city

Exploiting new technologies, including installation of sensors (e.g. fibre-optics) in water wells, boreholes and in the soil profiles, combined with satellite data, offers the opportunity to monitor environmental change and ground conditions against a baseline established before the city is built. These data can contribute to the Smart and Big Data agendas of the city, and so to its sustainability, resilience and future-proofing.

Hence, as the large (14,000 ha) concrete urban platform develops in the landscape, impacts on ground stability and disruption of the natural flow and availability of groundwater at depth will be identifiable. These, coupled with monitoring of climatic and other environmental changes, particularly associated with the River Krishna (local/regional soil erosion, changes in sediment flux, flooding), can be managed holistically with sustainable use of subsurface resources (water, energy, cooling, space, storage). Finally, Amaravati is located in Seismic Zone III (moderate damage risk zone - ref as per IS 1893:2002) and the Geological Survey of India seismo-tectonic map shows more than 20 faults and lineaments in the region including major faults passing through the capital region. These and other potential hazards will require consideration.



River Krishna in flood at the Beechpalli Bridge, October 2009

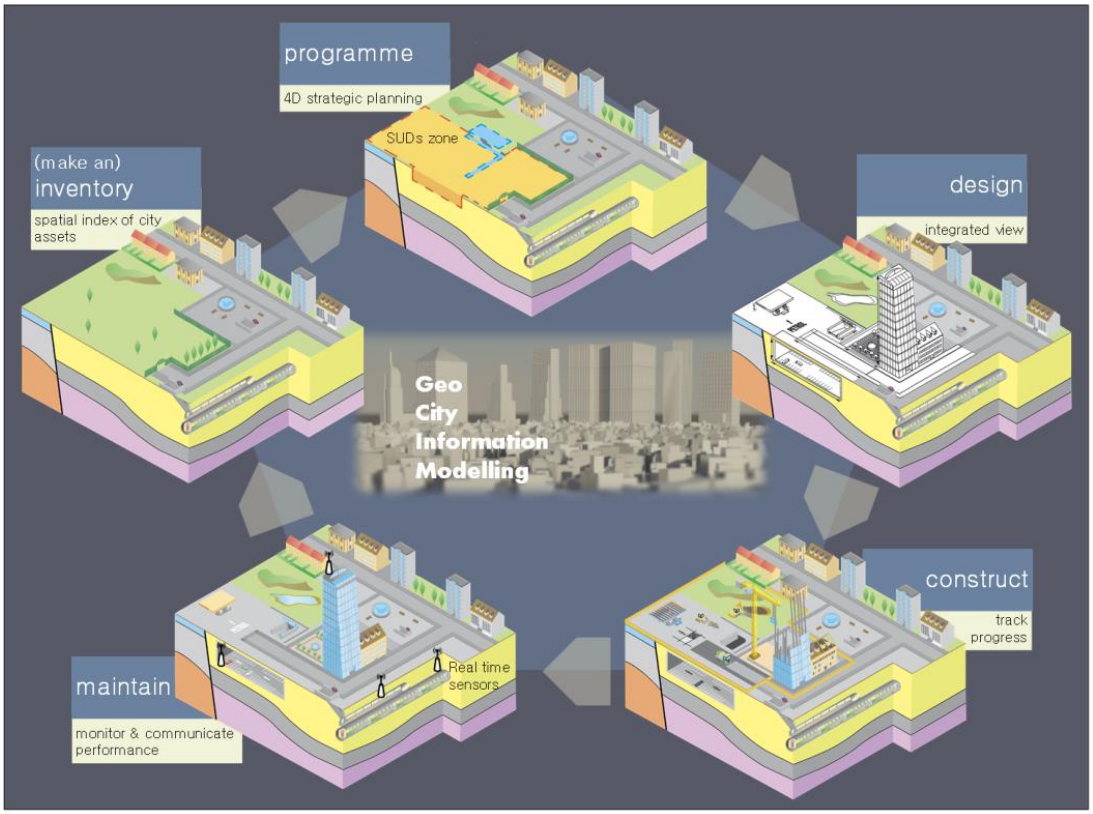
Approach

The new Smart City of Amaravati is an unparalleled applied research opportunity that will deliver integrated below- and above-ground planning. For many cities around the world this form of integrated planning only happens when we retrofit or adapt an established (often ancient) city. Amaravati is the opportunity to plan and to do this NOW and during development.

BGS would seek to link not only natural, social and human scientists in India and the UK but also work with technologists, engineers and planners to develop a real time sensor network linking sub-surface processes and environments to surface human activities

Early adoption of a system for city-scale digital data acquisition, management and multiple re-use (from ground investigation: geo-properties, groundwater quality and level, etc.) is an essential first step, Introduction of standardised data reporting, using industry standard data exchange and established templates pioneered by BGS, is a quick win which would pay long term dividends.

Our aim is to make all spatial data relevant to planning decisions available in a common data environment, and provide easy access to all related information at each stage of the strategic planning process and effective delivery of infrastructure as shown below.



Geo City Information modelling (GeoCIM) – integrated, city-scale below- and above-ground modelling, to support city development in harmony with its sub-surface and resources Mielby et al. 2017 (www.sub-urban.eu).

Improved data acquisition, and integration with data from other sources, will lead in turn to:

- Better ground Investigation (invasive and non-invasive using cutting edge and cost-effective techniques) reinforced by progressive advance in knowledge of the ground
- Multi-dimensional modelling of the sub-surface, a field in which BGS excels on city-scales, from traditional 3D models, to data-rich, semi-automated and predictive stochastic models
- Better informed planning construction decisions, fully cognisant with sub-surface opportunities and constraints

We now seek opportunities to explain the sub-urban agenda and our experiences elsewhere to the Andhra Pradesh Capital Region Development Authority, and designers and planners at Amaravati. Working initially with the Geological Survey of India, BGS could commit seedcorn funding in 2017-18 to develop the concept and pilot surveys with the intention of seeking longer term funding to develop a full programme.

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***BGS-India partnership activities:** BGS has had long-standing engagement in India with recent DFID and RCUK funded projects on groundwater resources in the Indo-Gangetic Basin and urban modelling in Varanasi and currently is carrying out NERC-funded research on groundwater supply in Bangalore and landslide risk in Darjeeling and Kerala. We have strong links with several universities (e.g. IIC Bangalore, IIT-Kharagpur etc.) and the Indian Government and its agencies (e.g. Geological Survey of India, National Institute of Hydrology) and are involved in student supervision and capacity training.*