GIS for SUSTAINABLE LIVING

The global population is on the rise. This rising population is consuming nature's finite resources at a fast pace, forcing all of us to ponder over the crucial question - ***"Are we leaving enough for the future generations?***

The answer lies in sustainable development. Growth now needs to be inclusive. It is time we start working diligently towards creating systems that are "sustainable", ones that will keep on working indefinitely in the future.

Sustainability is essential for the survival of future generations as well as for ensuring that all humans can fulfil their potential and contribute to society. With the United Nations adopting the 2030 Agenda for Sustainable Development and deciding on 17 Sustainable Development Goals (SDGs), the significance of linking people, planet & prosperity has got unanimously recognized at all levels.

Nations worldwide are actively working towards achieving the SDGs and the progress achieved so far establishes the fact that GIS is fundamental to sustainable development. It is a tool that helps in visualising and understanding areas in danger of biodiversity loss, habitat degradation and resource depletion. By applying the Science of Where we can respond more effectively to humanitarian crises, support sustainable development, protect critical habitats, preserve places that matter and achieve more.

As Jack Dangermond, Founder & President, Esri puts it, "The use of GIS has changed how people understand our world and create practical solutions. We are very appreciative of this acknowledgement. It illustrates the increasing recognition of the role geoscience is playing in our global evolution." By leveraging the powerful GIS technology in new ways, we can build a better world by ending poverty, inequality, climate change, improving health and more.

At present, there are many successful case studies that showcase how geospatial data is being used to meet the sustainable development goals – directly or indirectly. Geospatial data, when combined with other statistical data, enables nations to create visualisation tools that help accurate assessment and evaluation of the development impact across the 17 goals in a consistent manner such that accountability is improved. Organisations like UNGGIM are constantly stressing on and advocating the need for the aggressive use of geospatial information and technology to enable societal benefits of SDGs.

Mapping climate change

Human activities and global warming are rapidly contributing to environmental degradation. Decreasing glacier area, unprecedented rainfall, changes in land use and land cover, forest degradation, floods, landslides and shortfalls in agricultural crop production are among the many problems brought on by environmental changes. These issues need timely monitoring and supervision. Effective monitoring of the environment and an improved understanding of the same requires valuable information and data that can be extracted through application of geospatial technologies such as remote sensing and GIS. As Jack says, "Climate change is a geographic problem, and we believe solving it takes a geographic solution. GIS users represent a vast reservoir of knowledge, expertise, and best practices in applying this cornerstone technology to the science of climate change and understanding its impact on natural and human systems."

A number of organisations around the world are already using GIS to make better decisions in the face of the changing climate conditions. One of the best examples is The Nature Conservancy's suite of online mapping decision support tools that are powered by the ArcGIS platform. Government agencies and other organisations are using tools like this to easily examine how to prepare for and respond to storm surge and flood damage. Since their introduction in 2008, the tools have been used for disasters both big, such as Hurricane Sandy, and smaller, such as coastal erosion in Washington State's Puget Sound region.

Changing climate conditions are also largely affecting life on land and life below water. Today we are seeing unprecedented land degradation, and the loss of arable land at 30 to 35 times the historical rate. Drought and desertification is also on the rise each year, affecting poor communities globally. Of the 8,300 animal breeds known, 8 percent are extinct and 22 percent are at risk of extinction. The SDGs aim to conserve and restore the use of terrestrial ecosystems such as forests, wetlands, drylands and mountains by 2020. Halting deforestation is also vital to mitigating the impact of climate change.

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Urgent action must be taken to reduce the loss of natural habitats and biodiversity, and biologists, ecologists and environmental regulators are relying on the analytical power of GIS for making critical decisions to manage the same. GIS is aiding in development and design of functional wildlife corridors and contributing to their effectiveness as an increasingly viable conservations planning strategy. For instance, Esri used GIS to develop a new tool for wildlife corridor design within the Sonoran Desert, a biologically diverse region that spans southern Arizona and California in the United States and Baja California and Sonora in Mexico.

It is also essential to manage the world's oceans to counter balance the effects of climate change. Over three billion people depend on marine and coastal biodiversity for their livelihoods. Today almost 30

Bhopal Smart City using GIS

Following the Indian Government's Smart Cities Mission, Bhopal is selected as one of the 20 lighthouse cities in the first round of the project. The core infrastructure elements in a smart city include adequate water supply, assured electricity supply, sanitation, including solid waste management, efficient urban mobility and public transport, robust IT connectivity and digitalisation, good governance, especially e-governance and citizen participation, sustainable environment and safety and security of citizens, particularly women, children and the elderly.

Bhopal Smart City Development Corporation, as a part of its Smart City initiative, envisaged a technology solution that could cater to the smart citizens of this new age and modern Bhopal. Bhopal Smart City Organisation was looking for a platform which can provide information to the citizens on what is happening and take citizens feedback, this was just the first step and was very important because they want citizens to be a part of it.

Smart Map Bhopal is envisioned as a city level GIS portal that will act as a one-stop destination for citizens, businesses and government departments to discover, consume and share information about Bhopal. Smart Map Bhopal, a web application that seamlessly functions across various devices has been developed using the Esri ArcGIS.

percent of the world's fish stocks are overexploited, reaching below the level at which they can produce sustainable yields. Marine pollution, is reaching alarming levels, with an average of 13,000 pieces of plastic litter to be found on every square kilometre of ocean. The SDGs aim to sustainably manage and protect marine and coastal ecosystems from pollution, as well as address the impacts of ocean acidification.

GIS has the potential to play a major role in the accomplishment of this goal, and Esri's recent partnership with Ocean Health Index (OHI), the first program to comprehensively assess ocean health, is a concrete step in this direction. The OHI itself is a joint project of Conservation International and the National Center for Ecological Analysis and Synthesis. Together, the organisations have integrated OHI scores as a data layer in Esri's ArcGIS Living Atlas of the World and will launch Ocean Health Hubs, which are online tools that enable ocean managers to explore data to better understand regional ocean health. In times to come, we hope to witness more sustainable ocean management decisions, as these newly accessible datasets will allow the users to better understand their regional ocean health.

There is no country in the world that is not experiencing first-hand the drastic effects of climate change. Greenhouse gas emissions continue to rise, and are now more than 50 percent higher than their 1990 level. Further, global warming is causing long-lasting changes to our climate system, which threatens irreversible consequences if we do not take action now. Green energy has become a necessity today, and GIS is becoming a facilitator in this domain as well. Moreover, as natural sources of energy are depleting fast, GIS based solutions are largely helping in finding the best site locations for wind, solar and other alternative energies.

Green energy with GIS

Efforts to encourage clean energy has resulted in more than 20 percent of global power being generated by renewable sources as of 2011. Still one in seven people lack access to electricity, and as the demand continues to rise there needs to be a substantial increase in the production of renewable energy across the world.

GIS is currently being used to analyse the potential for renewable energy (RE) as a source for producing electricity and biofuels around the world. Many models are being developed to aid in planning for renewable technology to replace existing fuel sources or to be introduced into rural areas with no current electrical

Wind and Solar- Alternate energy resources

infrastructure. These analytical tools are enabling policy-makers, utility companies, planning commissions and environmentalists to develop renewable energy resources, and also search for the best locations and corridors for transmission and distribution.

Just like energy, another natural resource that is under great threat of exhaustion is water. With population rising at an unprecedented rate, more than 40 percent of people around the world are plagued by the problem of water scarcity. And, what's more? This alarming figure is projected to increase with the rise of global temperatures as a result of climate change. Although 2.1 billion people have gained access to improved water sanitation since 1990, dwindling supplies of safe drinking water is a major problem impacting every continent.

In 2011, 41 countries experienced water stress. Increasing drought and desertification is already worsening these trends. By 2050, it is projected that at least one in four people will be affected by recurring water shortages. To ensure universal access to safe and affordable drinking water for all by 2030, we need to act today and location intelligence can help us move closer to this goal as well.

Clean water and sanitation for all with GIS

Water is a scarce resource which must be preserved for our future generations. When a waterline breaks, customers are without water, and industries may have to stop production. To repair the break, water department employees spring into action, quickly responding to water outage complaints no matter what hour of the day or night.

Department superintendents are responsible for routing crews to multiple problems simultaneously. If crew members do not know the exact location of underground lines, locating lines and determining connections will take longer. This means customers may be without water longer, more water will pour onto the ground and be wasted, and additional expense will be incurred by the water department, which ultimately results in higher rates for customers.

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Source: Mapping a Healthier Future Report, published by the Uganda government with the World Resources Institute

Water Management

Current and accurate information about underground waterlines is critical for water departments and this is where GIS helps. These lines are mapped, and updated copies of these maps are distributed to water departments periodically. For faster action and minimal wastage, it is necessary to map the small lines along with the large lines. Delay in locating a break in a water line can cause wastage of this vital resource. GIS and mapping can significantly help in reducing the wastage.

Along with managing water wastage, we need to pay attention to the rising levels of water pollution. The widespread problem of water pollution is jeopardizing our health. Unsafe water kills a large number of people each year. Meanwhile, our drinkable water sources are finite: Less than 1 percent of the earth's freshwater is actually accessible to us. Without action, the challenges will only increase by 2050, when global demand for freshwater is expected to be one-third greater than it is now.

Water pollution has been a pressing issue in India. Consequently, the Government of India is taking concrete steps to clean as well as conserve the water bodies. The National Mission for Clean Ganga is one such initiative, which employs GIS technology for the Ganga rejuvenation task.

The key to an intelligent water system is having one go-to repository for all data. Intelligent water management begins with GIS. GIS software goes beyond locating pipes and facilities. It can be used to manage an asset registry, analyse system performance, optimise work, and easily collaborate. Strong mapping and analytics combined with easy-to-use apps allows one to

Cleaner Ganga with GIS

The National Mission for Clean Ganga (NMCG), a nodal authority to implement and monitor the government's ongoing 'Namami Gange' (Ganga rejuvenation) program, has tied up with the Survey of India to have high-resolution Digital Elevation Models (DEM) to monitor the entire basin.

This would not only help in identifying the entire topography, but also help the policymakers to make more informed decisions. These models will provide valuable information for use not only in making urban river plans but also for identifying baseline of river floodplains and regulating them for their restoration and preservation.

The high-resolution GIS-enabled data will help in regulating the proposed protected and regulatory zones along the banks of river.

The area of this project extends up to 10 km on both sides of the banks of Ganga. The major task of the project is to unite GIS ready database along with administrative boundaries up to village level and make proper public drainage network database under it.

GIS will also help to assess the water quality of the river. Currently, the ISRO backed Bhuvan Ganga Geoportal is actively playing its role in monitoring of water quality, hydrology, geomorphology and bio-resource.

see how today's actions affect tomorrow's water system.

A primary challenge for government agencies working on water and sanitation issues is coordination – planning and implementing effective interventions across multiple sectors and actors. Data is often siloed, with poverty figures kept separately from information on water access, sanitation and hygiene.

A report, Mapping a Healthier Future, published by the Uganda government with the World Resources Institute, shows how new kinds of mapping can help tackle these coordination problems and lead to more effective interventions. GIS maps are valuable tools to help overcome common coordination challenges. Better information means better decisions about how to allocate resources, and a good map can literally put all parties on the same page, opening the door for more efficient, transparent decision-making.

An examination of spatial relationships between poverty, safe drinking water, improved sanitation and better hygiene behaviour, not only fosters healthier living among people, but also provides new information to help craft more effective and evidence-based poverty reduction efforts. This kind of spatial information also empowers the public to query government priorities, advocate for alternative interventions and demand better decision-making.

Smarter, healthier people enable creation of more sustainable cities and communities, which are a necessary ingredient of sustainable development.

India is showing a strong commitment towards developing smart and sustainable cities. The Government of India has set up the Smart Cities Mission, according to which it intends to develop 100 citizen friendly and sustainable cities across the country. Bhopal has been amongst the 20 lighthouse cities.

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Sustainable cities with GIS

Making cities safe and sustainable means ensuring access to safe and affordable housing, and upgrading slum settlements. It also involves investment in public transport, creating green public spaces and improving urban planning and management in a way that is both participa-

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tory and inclusive. GIS based urban analytics is the answer to many complex issues that today's cities face.

Urban analytics helps cities figure out the questions that they need to ask in order to drive for any type of measure – health, safety and sustainability. A question about sustainability that usually gets translated into urban analytics is quality of buildings. It can help in analysing how to identify, track and predicatively find buildings that are likely to challenge a building quality, or how to fix those buildings. For instance in New York City, Esri used a reactive facade strategy, which helped it to know that a facade was dilapidated, and the building was going to fall down. We can take a historical view of all of the buildings and record their specifications, year of establishment etc. to understand when a facade is ultimately going to crumple. Such findings would ensure sustainability. Urban analytics can be used to ensure that buildings are designed in a way that uses better material or less material, less energy and still meet all the requirements.

It is estimated that by 2051 India will be considered as an urban nation. With a continuous increase in the urban settlement, the country needs a sustainable and equitable urban settlement plan. The Atal Mission for Rejuvenation and Urban Transformation (AMRUT) aims to provide solutions regarding sustainable coverage of water supply, sewerage facilities and more facilities for non-motorized transport.

Master plans required to spearhead AMRUT mission are based on base maps which need crucial and accurate information regarding planning areas, building layouts, spatial information on development, use of each portion of land, etc. To facilitate such detailed real-time monitoring and assessment of spatial data like growth of cities/towns, land-use status, and physical infrastructure, etc. GIS was adopted.

The move to improve the integration of GIS with BIM is one of the ways Esri is helping design smart communities.

The formulation of GIS-based master plans is one of the key reforms under AMRUT.

GIS can significantly aid in monitoring an area or conducting a feasibility study of a location for a specific purpose, for instance ascertaining the suitability of a location for the construction of a bridge or dam. Feasibility studies of smaller structures like schools and hospitals can also be carried out effectively using GIS.

GIS also helps in identifying changes in geographical features or behaviour of a land over a specified time. Such information enables professionals to make informed decisions about the development condition of an area and plan accordingly. Planners make use of GIS to smooth the progress of citizen participation and community input as they develop a vision for the community that enhances the quality of life for all citizens. Citizens are the life and blood of any city and first-hand inputs from them as to what can be done to make their city smarter can aid in crafting out amazingly productive methods/means for urban planning. PPGIS (public participatory GIS) platform enables this effective engagement process.

People can contribute more effectively towards creating a more sustainable future if they acquire the knowledge, skills, attitudes and values necessary to shape the same. Education is one of the most powerful and proven vehicles for sustainable development. Education for Sustainable Development, of which education in GIS is an integral part, empowers people to change the way they think and work towards a sustainable future.

Esri has been playing an important role in creating such awareness by providing more than 7,000 universities worldwide with software for teaching and research, supporting primary and secondary schools, libraries and youth organisations, and partnering with organisations like the National Geographic Society and Association of American Geographers on projects like GIS Day and the GeoMentor program. Such initiatives amplify Esri's conviction that by working together, we can apply our collective geospatial work to achieve remarkable and ambitious projects such as The United Nation's 2030 Global Agenda for Sustainable Development and its 17 goals. We need to move from a future that simply happens to one that is purposefully designed, with a full understanding of the consequences. This will take more conscious and collective action, with GIS being the common thread.