Arc India News

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GIS Heralds Harvest High

Case Study
Putting Agronomic Analysis in the Hands of Farmers

Global View
Tracing Each Oyster from Tide to Table

Product Showcase
ArcGIS Urban Transforms City Planning

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THE SCIENCE OF WHERE™

SEE
WHAT
OTHERS
CAN'T™

Agendra Kumar
President, Esri India

Agriculture plays a very significant role in the overall economic outlook for India. However, adoption of new technologies in the Indian Agriculture sector is still not at the international level. Only few states have implemented digital land record systems and production depends largely on monsoon. Urbanization, climate change, natural / man-made disasters adversely impact farm yield and thus farmers' income.

The technological advancement in Agritech offer promising solutions to improve the overall yield and productivity of the sector. Precision farming and precision protection are gaining ground. GIS and Remote sensing, in particular, are driving major innovations. Start-ups are creating innovative solutions - from hand-held food adulteration meters, to highly integrated databases that deal with multiple marketing chains. Even Indian government has acknowledged the central role of geospatial technology in proactive and dynamic policy-making that will help double farm incomes. At least four of eight sub-missions under the National Mission for Sustainable Agriculture, and the Pradhan Mantri Krishi Sinchai Yojana depend on spatial analysis powered by GIS.

Today, the chance to bring a real paradigm shift lies in the hands of geospatial experts everywhere. Convergence of GIS, IoT, Big Data Analytics and Artificial Intelligence / Machine Learning offers opportunities to solve the complex problems of this sector. By applying the 'Science of Where', you can drive new revolution in this sector by 'Seeing What Other's Can't'.

Agendra Kumar

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Esri India and Indian Institute of Technology-Banaras Hindu University (lIT-BHU) are gearing up to geospatially skill millions

Esri India and IIT-BHU are all set to put their formidable heads together to provide geospatial technology, support, and skilling for government programmes. An MoU signed in May envisages a Centre of Geospatial Excellence that will develop domain-specific geospatial skills, which are crucial for government programmes like Namami Gange, Sagarmala, and the Smart Cities Project.

According to the MoU, technical know-how and resources will be developed specifically for use in Uttar Pradesh and neighbouring states. These are also the areas that form the watershed for the Defence Industrial Corridor Mapping project. This initiative led by the UP government is aimed at boosting indigenous production of defence equipment, along the lines of Make in India. Three thousand acres allotted to defence industries will be mapped into land parcels for transport infrastructure, ancillary industries, etc., using GIS technology.

As Esri India president, Mr. Agendra Kumar, highlighted, it is "imperative to introduce GIS technology in the learning process of students, and increase the availability of GIS professionals in India", given the steady uptake of GIS as a base in government programmes. The venture is expected to create GIS manpower that can undertake mapping for future projects. ∎

Esri and the Jane Goodall Institute Partner to Provide Community Mapping Tools to Protect Nature

Esri, the global leader in location intelligence, recently announced a partnership with the Jane Goodall Institute (JGI) to develop a set of tools that will help communities map and manage the ecosystems around them through a collaborative design and planning approach, aided by GIS software.

These tools will help communities map, monitor, and better manage their natural resources from community forests and wildlife reserves to water catchment and flood control areas as well as human settlement, agriculture, and agroforestry spaces.

Started in 1994 as a project around Gombe National Park in Tanzania, where Dr. Goodall led her pioneering research on wild chimpanzees, the JGI has a community-centered conservation approach, called Tacare. In partnership with local communities and governments, the institute creates sustainable livelihoods while planning for, and advancing, environmental protection.

"A key component of our success is that we work to help villagers find ways to make livelihoods that do not destroy the environment, and help them understand that protecting the environment not only conserves wildlife, but their own future," said Dr. Jane Goodall, DBE, founder of the JGI & UN Messenger of Peace.

The JGI's Tacare approach achieves conservation results and addresses threats by first consulting communities about their needs and priorities, while also contributing to conservation. The JGI uses Esri's ArcGIS platform and Survey123 mobile app to help communities and governments in western Tanzania, Uganda, and other countries in Africa to plan, monitor, and protect chimpanzee populations in local protected forests outside designated national parks. ∎

Esri to Use Mobileye Data for Dynamic Edge Mapping

Esri, the global leader in location intelligence, recently announced collaboration with Mobileye, an Intel Company and a leading provider of advanced driver-assistance systems software, to bring the advanced data collection capabilities of Mobileye into Esri's platform as native services. This collaboration will provide Esri customers with the ability to visualise and analyse real-time HD maps and location data streaming from sensors on vehicles equipped with Mobileye technology, enabling a new type of living, dynamic map on the Esri platform.

Under the agreement, vehicles equipped with Mobileye's vision system will gather information that will serve as a basis for several new data services on the ArcGIS platform targeting local government, transportation and insurance markets. Over the coming months, Mobileye will publish data onto the ArcGIS platform to enable millions of ArcGIS users with dynamic data that serves specific industry applications and will lead to better understanding for both government and commercial customers.

The new agreement vastly expands upon the existing relationship between Esri and Mobileye to include the latest EyeQ4 collection capabilities, bringing advancements in both safety and data collection. The agreement enlarges both the scope of data available to Esri customers, as well as the accessibility to it.

"Mobileye vision from a passing vehicle will automatically inform city workers that a stop sign has an obstructed view for instance," said Jim Young, Esri head of business development. "The sign will show up on an Esri map and a service crew can be dispatched to fix it, using ArcGIS technology."

"We live in a world that changes every day," said Lior Sethon, Vice President and Deputy General Manager of Mobileye Aftermarket Division. "Our data solutions help reflect those constant changes in high-quality resolution. With Esri, we are extending the value of our HD maps beyond the automotive market for the broad range of Esri customer use-cases."

"For our industry, this is the next generation," adds Jim Young. "Just like edge computing, this is edge mapping—using anonymised and generic data captured by vehicle-mounted cameras and computer vision for instant map updates. We are thrilled to be working with Mobileye."

The dynamic nature of this new data source will enable better decision-making and greater automation for Esri customers, ultimately enabling safer streets and smarter communities. ∎

Esri Releases GIS and the 2020 Census

Esri, the global leader in location intelligence, recently announced the publication of *GIS and the 2020 Census: Modernizing Official Statistics*.

In preparation for the 2020 round of censuses comes a book providing statistical organisations with the most recent methodologies and technological tools to support all stages of the census. *GIS and the 2020 Census* supports the transformation of countries' censuses with the use of GIS software and related geospatial technologies to improve data collection, analysis, and dissemination, and to enable agencies to build accurate, authoritative, actionable data.

It covers planning, enumeration, and field data collection, and post-enumeration tasks such as converting existing data, field operations, data processing and dissemination, developing geographic products, and much more. Case studies from Albania, Portugal, Republic of the Philippines, Jordan, Arab Republic of Egypt, Ireland, and Canada demonstrate the successful application of the tools. ∎

Esri Partners with E.O. Wilson Biodiversity Foundation to Establish Half-Earth Project Conservation Priorities

Esri, the global leader in GIS technology, has announced its partnership with the E.O. Wilson Biodiversity Foundation. Esri will be providing the mapping and analytics capabilities of the ArcGIS platform to the foundation's Half-Earth Project.

This initiative aims to conserve half the earth's lands and seas in order to reverse the species extinction crisis currently threatening the planet.

The partnership between Esri and the foundation includes commitments by Esri to provide its geospatial cloud, ArcGIS Living Atlas of the World, and significant geospatial and geoscience expertise, as well as financial support.

"In order to realize a vision on the scale of Half-Earth, we need to mobilise virtually everybody on the planet. It's crucial that we bring together our best minds, our strongest science, and humanity's best intentions to achieve positive results," said Jack Dangermond, Esri founder and president.

The Half-Earth Project was inspired by the book, *Half-Earth: Our Planet's Fight for Life*, written by American biologist and naturalist, E.O. Wilson.

"This partnership with Esri could not have come at a more important time for biodiversity and the future health of our planet," said Wilson. "With the biodiversity of our planet mapped carefully and soon, the bulk of the earth's species, including ourselves, can be saved." ∎

Esri Software Powers Location Intelligence in Microsoft's Defence System Demonstration

Esri has announced that Microsoft's Tactical Edge Platform will use Esri's ArcGIS Enterprise to give Microsoft Azure and Azure Cognitive Services a geographic context through Esri's advanced mapping and spatial analytics technology. The platform is intended to demonstrate now defence and intelligence professionals can utilise connected field-sensor data and cloud services for domestic emergency response or for tactical field operations support in war theaters.

Soldiers or disaster response field personnel, coupled with mobile phones turned autonomous ground sensors, can capture the seen and unseen world around them with elements ranging from wireless infrastructure to photos of the population. That data is transmitted to ArcGIS, residing in Azure and using Azure Cognitive Services to apply artificial intelligence to the collected data. The AI-processed results are fused with ArcGIS's spatial analytics, and become actionable across the ArcGIS platform, extending pushing results forward into a tactical vehicle's displayed ArcGIS Operations Dashboard.

Market research firm Forrester recognized Esri in *The Forrester Wave™: Location Intelligence Platforms, Q4 2018 Evaluation*, which acknowledges Esri's leadership in location intelligence technology and highlights the company's long-term commitment to innovation in its market-leading geospatial cloud.

To learn more about how Esri is transforming field operations in defence and intelligence, visit *go.esri.com/geointmspr*. ∎

Putting Agronomic Analysis in the Hands of Farmers

As stewards of our resources, farmers and ranchers understand the importance of both production and resource conservation. However, it is not always clear how to protect our natural resources while maintaining productivity. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) works with farmers and ranchers to ensure the health of our natural resources and the sustainability of agriculture.

> "The STAR user interface makes the powerful, albeit complex, APEX tool intuitive to use. It allows conservation planners in Vermont to easily optimise which conservation practice alternatives to offer to agricultural producers by quantifying estimated nutrient reductions associated with those alternatives and by providing these estimates in a geospatial context. It is a game-changer for Vermont."

Michael Middleman,
Partner Liaison,
Vermont Agency of Agriculture Food & Markets

THE CHALLENGE

NRCS helps farmers and ranchers develop a conservation strategy. Whether it be to improve the health of soils and water or restore wetlands and wildlife, NRCS strives to boost productivity while protecting our natural resources. To analyse the high variability in soil type, terrain, cropping patterns, and weather, the Texas A&M University Blackland Research & Extension Center developed a spatial agricultural water quality model, the Agricultural Policy/Environmental Extender (APEX). However, the tool is too complex for most; only trained scientists have been able to use it, leaving out those who can greatly benefit from it—the farmers and conservation planners.

THE PARTNER

Stone Environmental Inc., based in Montpelier, Vermont, provides scientific tools, information, and analyses to help clients solve complex environmental and data challenges. Stone's data and modelling expertise, along with its long-term relationship with the USDA and Texas A&M University's Spatial Sciences Lab, made the company an obvious choice

to develop a more user-friendly farm modelling system.

THE SOLUTION

To make the data from the APEX tool more widely available, Stone, in collaboration with Texas A&M University's Spatial Sciences Lab and Blackland Research & Extension Center, developed the Systematic Tool for Analyzing Resources (STAR) application. The web-based modelling tool, built on Esri's ArcGIS platform, simulates the impacts of alternative conservation practices applied across individual farms to help producers and conservationists assess resource more efficiently.

The STAR application incorporates all of the APEX model's required data, including soils, topography, hydrology, and climatology databases. Based on the location of the field, all the model parameters are extracted using a variety of GIS processing tools for input into the APEX model. After developing a baseline using existing field conditions and current farming practices, the STAR tool quickly provides data comparing the current situation with alternative farming and conservation practices.

THE RESULT

The STAR application provides farmers and ranchers with a powerful yet user-friendly tool to optimise production, improve water quality, and conserve soils. These producers can now analyse and compare the impacts of implementing conservation practices, like contour cropping, terraces, cover cropping, filter strips, and conservation tillage, anytime, anywhere, and on any device. The STAR application delivers complicated, multivariate analysis in an easy-to-consume format, in a fraction of the time required for previous practices.

Using STAR, Vermont NRCS and VAAFM are able to easily compare the impacts of current farming practices and cropping systems with conservation alternatives and identify more viable options. The tool enables conservation planners to deliver quantifiable farm management data in a geospatial context, allowing farmers to identify best practices to lessen erosion and nutrient loss while improving production and streamlining farm management. ■

STAR incorporates APEX data parameters that are extracted using a variety of GIS processing tools, to develpe a baseline that can help compare the current situations with alternative practices.

AGRICULTURE

USER
- NRCS, a nationwide organisation that helps farmers boost productivity while maintaining our natural resources

PARTNER
- Stone Environmental, Inc.

CHALLENGE
- Deliver advanced agronomic and water quality modelling analyses to farmers and ranchers

SOLUTION
- ArcGIS® for Desktop
- ArcGIS for Server
- ArcGIS API for Silverlight

- Microsoft® SQL Server®
- Agricultural Policy/Environmental
- Extender (APEX) Model

RESULT
- Enabled farmers to easily analyse their land to determine conservation practices while optimising production

THE FASTEST WAY TO COLLECT FIELD DATA

Today, users demand an extremely simple and streamlined data-collection user experience while on the go. ArcGIS QuickCapture is specifically designed to effectively support this through at-speed and rapid data collection workflows. Need a plan to save time? ArcGIS QuickCapture helps you send data back to the office for analysis in real-time, eliminating time spent on manually processing handwritten notes. At-speed asset inventories, aerial surveys, pipeline patrols, quick on-the-go inspections, or crop scouting are some of the workflows where ArcGIS QuickCapture excels.

WHAT MAKES ArcGIS

QuickCapture unique is its big-button experience, each button representing a type of field observation. You push/tap the button, and QuickCapture does the rest: it gets the location of your device and creates a GIS feature with predefined attributes. The ArcGIS QuickCapture mobile app

is available for iOS, Android, and Windows. It comes supported with ArcGIS Online and ArcGIS Enterprise 10.7.1.

POINT, LINE AND POLYGON BEHAVIOUR

How a tapped button behaves depends on whether the source layer is a point, line, or polygon.

- Line and polygon capture differ slightly from point capture. While points are captured when a respective point feature button is pressed, line and polygon capture is toggled on/off.

In a nutshell, QuickCapture is a rapid data collection app that lets you capture GIS features at the push of a button.

- Points can be captured at any time, and even while there is a line or polygon capture in progress.

- When a line or polygon capture is in progress, the respective button flashes to indicate it is active.

- The red circle inside a line or polygon capture button blinks each time a point captures a feature.

- Multiple line and polygons may be captured simultaneously.

- The default behaviour for line or polygon buttons within a group is to operate mutually and exclusively. Thus, when a new feature is started, the previous feature is automatically completed.

- Mutual exclusivity within a group may be turned off on a per-button basis using the 'Exclusive' property; groups can be re-defined using 'Group' property.

Here are a few of the many scenarios where this new data capture experience will streamline your workflows:

AT-SPEED ROAD ASSET INVENTORIES

Use ArcGIS QuickCapture while travelling in a vehicle, such as a truck or car. While one person drives, a colleague in the passenger seat can capture observations on the go; report the location of assets along the road; or document pavement conditions, all without stopping.

AERIAL SURVEYS AND PATROLS

Configure ArcGIS QuickCapture to collect geo-referenced observations from a helicopter, or by on-foot patrol crew. Use QuickCapture to document right of way infractions, malfunctioning streetlights, or even overgrown vegetation over electricity poles.

CROP SCOUTING AND NOXIOUS WEED ABATEMENT

Carry ArcGIS QuickCapture with you to quickly mark locations where pests affect growth, or invasive species are being found or treated. The application requires minimum training for field users.

QUICK DAMAGE ASSESSMENTS

Equip first responders, and even volunteers, with this extremely simple mobile app to perform quick damage
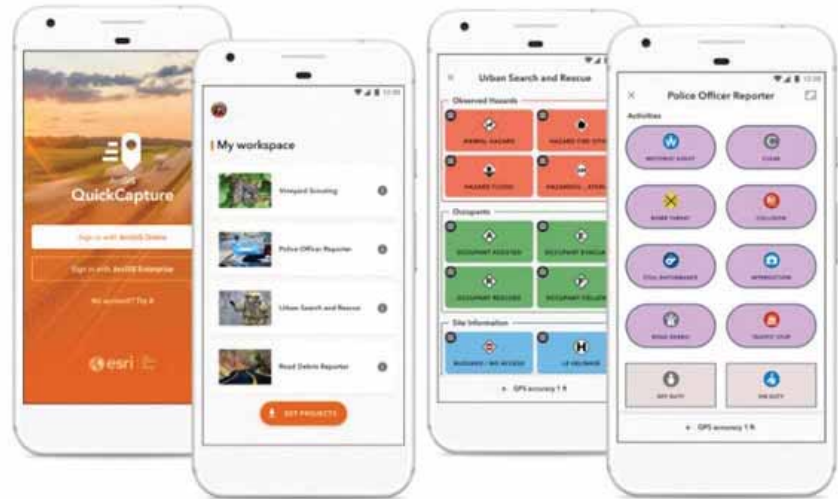
QuickCapture innovates upon the big-button experience; one tap creates a GIS feature with predefined attributes which is then integrated with ArcGIS.

assessments. Snap a photo and quickly categorise damage while driving through town.

KEY POINTS

- Substantially enhanced speed of data collection that eliminates the need to bring devices back to the office and download data, saving time for field users.

- Improved data accuracy due to real-time data capture.

- Real-time data transmission progress during field coverage.

- ArcGIS QuickCapture provides data in a ready-to-share hosted format.

In a nutshell, QuickCapture is a rapid data collection app that lets you capture GIS features at the push of a button. ArcGIS QuickCapture is integrated with ArcGIS, allowing new data from the field to be instantly used for better decision-making. ∎

ArcGIS QuickCapture

Tracker for
ArcGIS Released!

With location tracks inside of ArcGIS, Tracker authorises you to pinpoint the precise locations of your field workforce, monitor safety, and better coordinate personnel and resources in response to unplanned events. This nifty app ensures improved operational insights, and efficiency boosts that put you one step ahead of the game.

We are excited to announce the first release of Tracker for ArcGIS! Location matters. Know the real-time location of your most valued assets – your mobile workers – through a brand-new app, Tracker for ArcGIS.

Tracker includes a mobile app for iOS and Android devices that efficiently runs in the background to capture location tracks, then feeds these tracks directly into a location tracking feature service, a new capability within ArcGIS Enterprise 10.7 (ArcGIS Online support started in June). Location tracks can be viewed and interrogated by authorised viewers with the Track Viewer web app or other visualisation and analysis tools in ArcGIS that leverage its location tracking capability.

With location tracks inside ArcGIS, you can use the power of Esri's Geospatial cloud to gain meaningful insight into the location behaviour of your workforce:

- Create linear heat maps to visualise the density of location tracks over time.

- Aggregate tracks to analyse coverage over an area and identify gaps.

- Use incident detection to detect abnormalities in location behaviour.

- Verify where inspectors were when inspections were performed.

- Derive new datasets from locations travelled.

The mobile app for iOS and Android runs in the background, to capture location tracks that are fed into a new capability within ArcGIS Enterprise 10.7.

WHY USE TRACKER FOR ArcGIS?

Know where everyone is. Tracker enables field personnel to securely share their locations with supervisors who benefit from seeing where their workers are. Knowing the precise locations of your field workforce helps you to verify work, monitor safety, and better coordinate personnel and resources in response to unplanned events.

Review where people have been. Tracker stores location tracks so you can access and review them later. You can use stored location tracks to analyse the places workers visited during their shifts. This helps prove work was conducted at a specific location, measure whether contractors met service-level agreements, and even derive new datasets using the tracks collected.

Improve efficiency in the field. Analysing the location behaviour of your workforce can improve operational insight and boost efficiency. Find patterns that contribute to efficiency gains or losses, spot areas where you are not meeting compliance requirements, and identify potential process enhancements or corrections.

Support field personnel. Enable personnel to see where they are and where they have been, so it is clear whether the intended territory has been covered. When the day is done, the Tracker mobile app can be easily turned off by the user.

WHAT ARE THE COMPONENTS OF TRACKER FOR ArcGIS?

A base ArcGIS Enterprise 10.7 deployment plus spatiotemporal big data store. Tracker for ArcGIS is dependent on a base ArcGIS Enterprise deployment at version 10.7 plus the spatiotemporal big data base. An ArcGIS Enterprise Standard licence is all that is needed to deploy Tracker—all the GIS Server functionality and the spatiotemporal big data store is included.

Tracker for ArcGIS mobile app. The Tracker mobile app is a free download, available on the iTunes App Store, Google Play, and the Amazon Appstore. To sign into the app, field personnel need an add-on licence. This licence is available

Tracker for ArcGIS depends on ArcGIS Enterprise 10.7 as a base deploy, along with the spatiotemporal big database, called ArcGIS Data Store.

for use with any user type—including Viewers. To purchase Tracker add-on licences, contact your Esri sales representative.

Track Viewer web app. Track Viewer is a web app that administrators can use to create track views (feature service views) and supervisors can use to interrogate tracks. Track views include the list of mobile users being tracked and users that can view their tracks. The Track Viewer makes it easy to share views across the organisation.

HOW DO YOU GET STARTED?

You can learn more about Tracker for ArcGIS from the Esri.com product page.

Access the Resources page to learn more about how Tracker works. Our documentation resources will get you started. Here you learn how to enable location tracking, where you can download the mobile app, read our FAQ and see what is coming next. ■
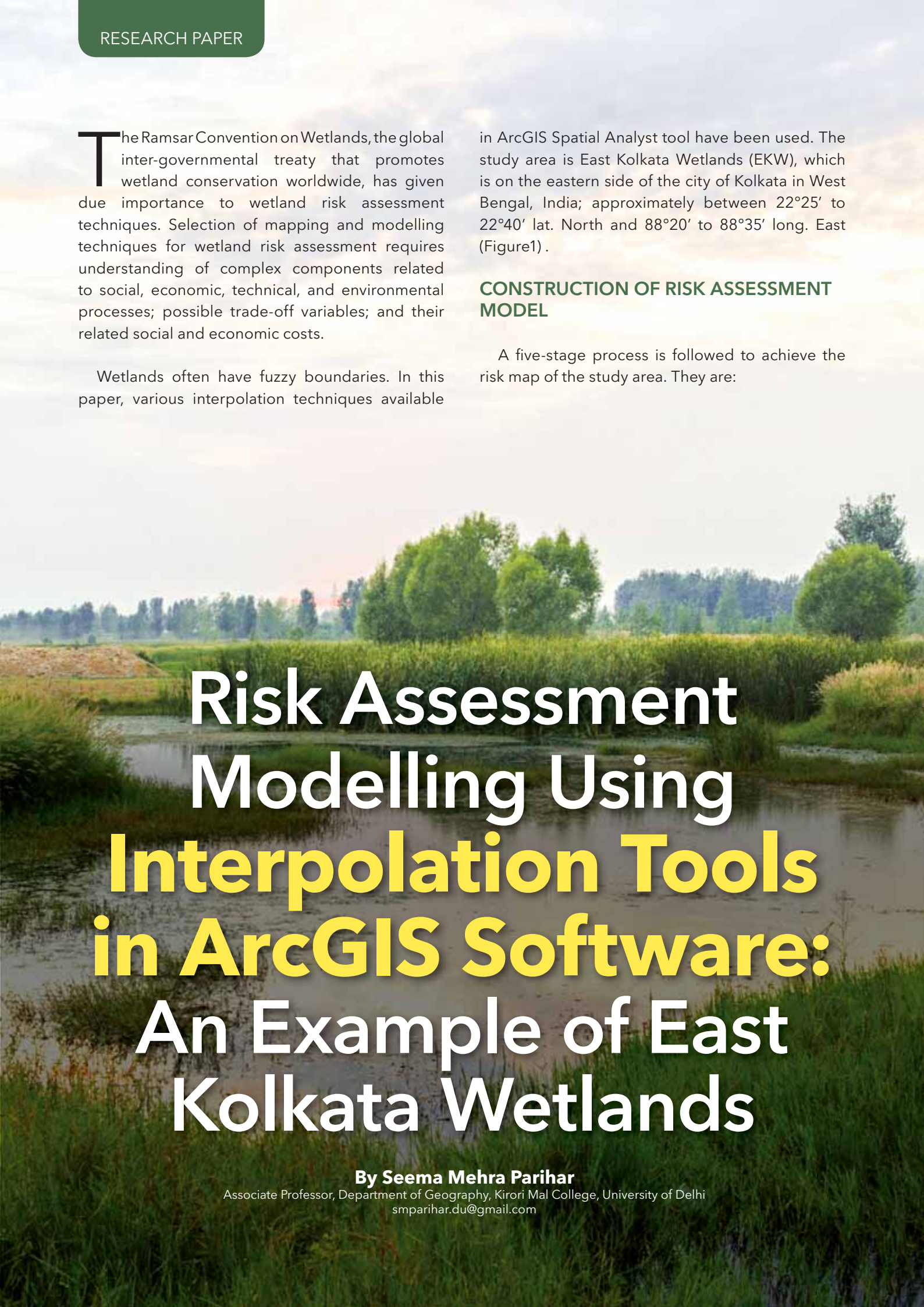
The Ramsar Convention on Wetlands, the global inter-governmental treaty that promotes wetland conservation worldwide, has given due importance to wetland risk assessment techniques. Selection of mapping and modelling techniques for wetland risk assessment requires understanding of complex components related to social, economic, technical, and environmental processes; possible trade-off variables; and their related social and economic costs.

Wetlands often have fuzzy boundaries. In this paper, various interpolation techniques available in ArcGIS Spatial Analyst tool have been used. The study area is East Kolkata Wetlands (EKW), which is on the eastern side of the city of Kolkata in West Bengal, India; approximately between 22°25′ to 22°40′ lat. North and 88°20′ to 88°35′ long. East (Figure1) .

CONSTRUCTION OF RISK ASSESSMENT MODEL

A five-stage process is followed to achieve the risk map of the study area. They are:

Risk Assessment Modelling Using **Interpolation Tools in ArcGIS Software:** An Example of East Kolkata Wetlands
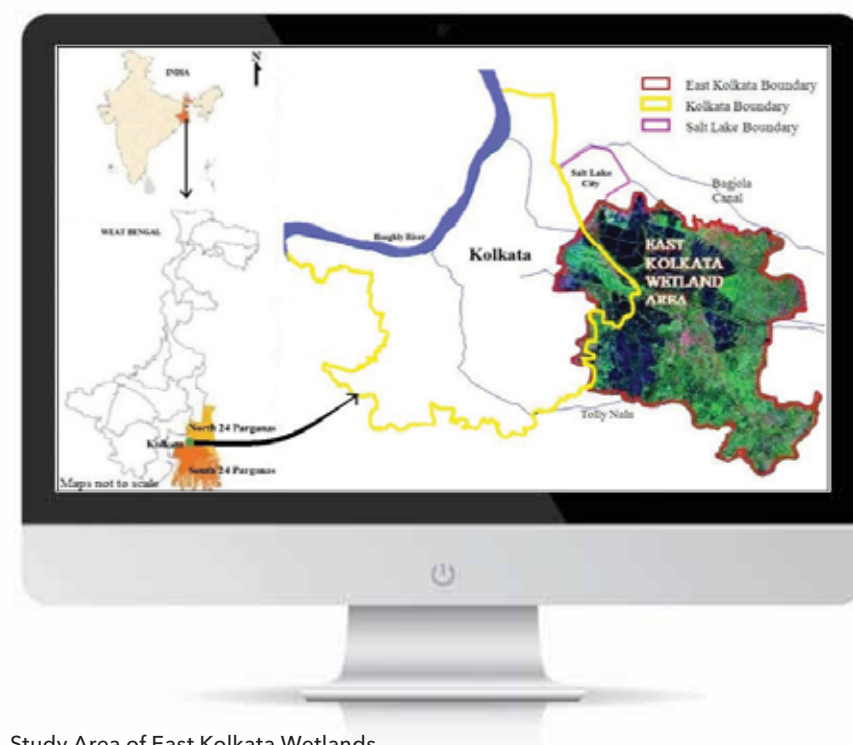
By Seema Mehra Parihar
Associate Professor, Department of Geography, Kirori Mal College, University of Delhi
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Wetlands are a crucial part of our natural environment. They provide a wide range of environmental, social and economic services, and are also known as biological supermarkets because of the rich biodiversity they support. These wastewater ecosystems are most commonly directly reused to produce fish and aquatic plants (duckweed) for human consumption, and high-protein animal feed. While proper assessment and mapping are essential for efficient utilisation and conservation of wetland ecosystems, much remains to be done.

(i) Problem identification and selection of model input indicators.

(ii) Determination of fuzzy sets and definition of linguistic variables.

(iii) Construction of fuzzy rules.

(iv) Determination and selection of operators and inference, and defuzzification methods.

(v) Model validation.

Study Area of East Kolkata Wetlands.

In this study, eight indices that address the most vital issues concerning the wetland risk of the EKW were selected. Since every ecosystem is unique, the inference model was developed through available scientific knowledge and expert opinion. At the first level, 22 indicators were selected, which were further consolidated into eight indices, namely wetlands conversion rate, canal proximity, road proximity, population density, population growth rate, infrastructure status, livelihood status and social status.

Owing to the functional complexity of the region, the indicators were aggregated to generate an index (Infrastructure

Composite Rank Index, Livelihood Composite Rank Index and Social Composite Rank Index) and were considered of equal weightage. Experts felt giving different weights to the indicators might make the study biased since all of them are significant for the index. All the selected indicators were categorised into ranks for standardisation in measurement.

For Fuzzy Inference System in GIS-based risk assessment modelling, raster-based datasets or maps are essential; they are

the major source of input for cell-based information modelling. Because obtaining values for each cell in a raster is typically not practical, sample points are used to derive the intervening values using interpolation tools in ArcGIS software. Various interpolation techniques available in the ArcGIS Spatial Analyst tool – PointInterp, Natural Neigbor, Trend fit, Inverse Distance Weight (IDW), Spline and Kriging interpolation – are all used in the study. Except road proximity and canal proximity, all the indices

were rasterised by the IDW interpolation method so that each pixel of the raster map could obtain an estimate of a property based on the values of the indicator's property at measured locations. The IDW interpolator assumes that each input point has a local influence that diminishes with distance. This weighted procedure, which is versatile, easy to understand and is fairly accurate under a wide range of conditions (Lam, 1983), is represented by

$$P_i = \frac{\sum_{j=1}^{G} P_j / D_j^n}{\sum_{j=1}^{G} 1/D_j^n}$$

(1)

where Pi is the property at location i; Pj is the property at measured location j; Dij is the distance from i to j; G is the number of measured location; and n is the inverse-distance weighting power. The value of n controls the region of influence of each of the measured locations. For this study, value of n was considered 2 since it gave optimal output for most of the cases (Shepard, 1968). Twelve measured points (maximum) were specified to determine the output value of each unmeasured point.

WETLANDS CONVERSION RATE

The wetlands conversion rate was calculated through remote sensing-based change detection technique, in which the Land-Use/ Land-Cover (LULC) maps for year 2002 and 2012 generated using Fuzzy C-Means (FCM)
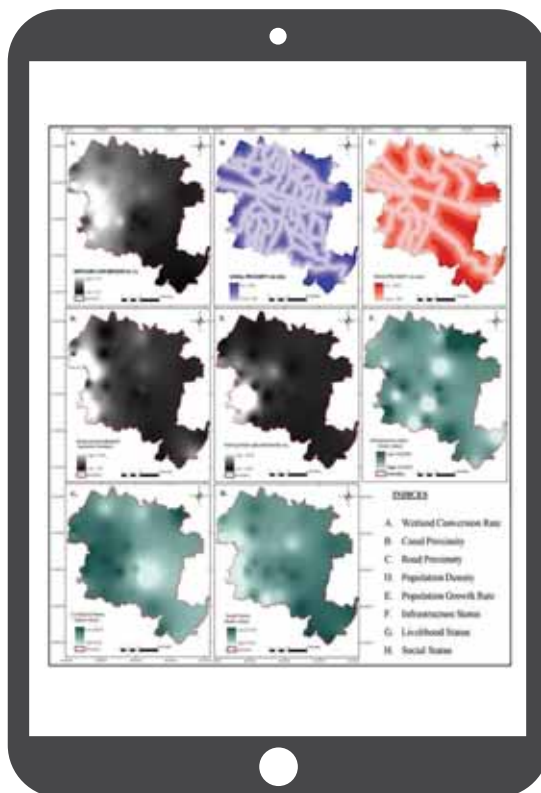
Final input indices' maps.

algorithm were compared. From the generated wetland change detection map, mouza-wise wetland change percentage (Wm) was calculated using the following equation

$$W_m = \frac{P_c}{P_m} \times 100$$

(2)

where Pm represents total pixel count in the mouza m and Pc represents the number of pixels changed from wetland class to other LULC classes in the mouza m.

Using the wetland-change percentage for all the 37 mouzas by IDW interpolation method, the wetland conversion rate map was generated.

RESULT AND DISCUSSION

The wetlands conversion rate

map was generated from the LULC maps for 2002 and 2012. To identify the areas where the conversion of wetlands to other land cover classes has taken place, change detection matrix was calculated and, subsequently, a wetland change detection map was generated. The final outputs of the rest of the indices, such as road proximity and canal proximity maps; population growth and population density maps; infrastructure status; livelihood status; and social status, have been presented in fig. 2.

MODEL RESULT ANALYSIS

The resultant output of the classification based on rule and model properties generated a soft output map with various shades of grey. The grey colour array represents the varying intensity of risk, ranging from 11 to 88 risk gradient. The gradual change of shade from dark to light indicates EKW conversion risk status increasing from low to high.

The whole EKW region was divided into five risk zones on the basis of obtained risk gradient scale (3): very high (>60), high (50-60), moderate (40-50), low (30-40) and very low (<30). Later, the risk zone classified map was superimposed by mouza boundary to identify the mouzas under different risk zones. The map shows that mouzas located close to the Kolkata city are under very high risk of wetland conversion.
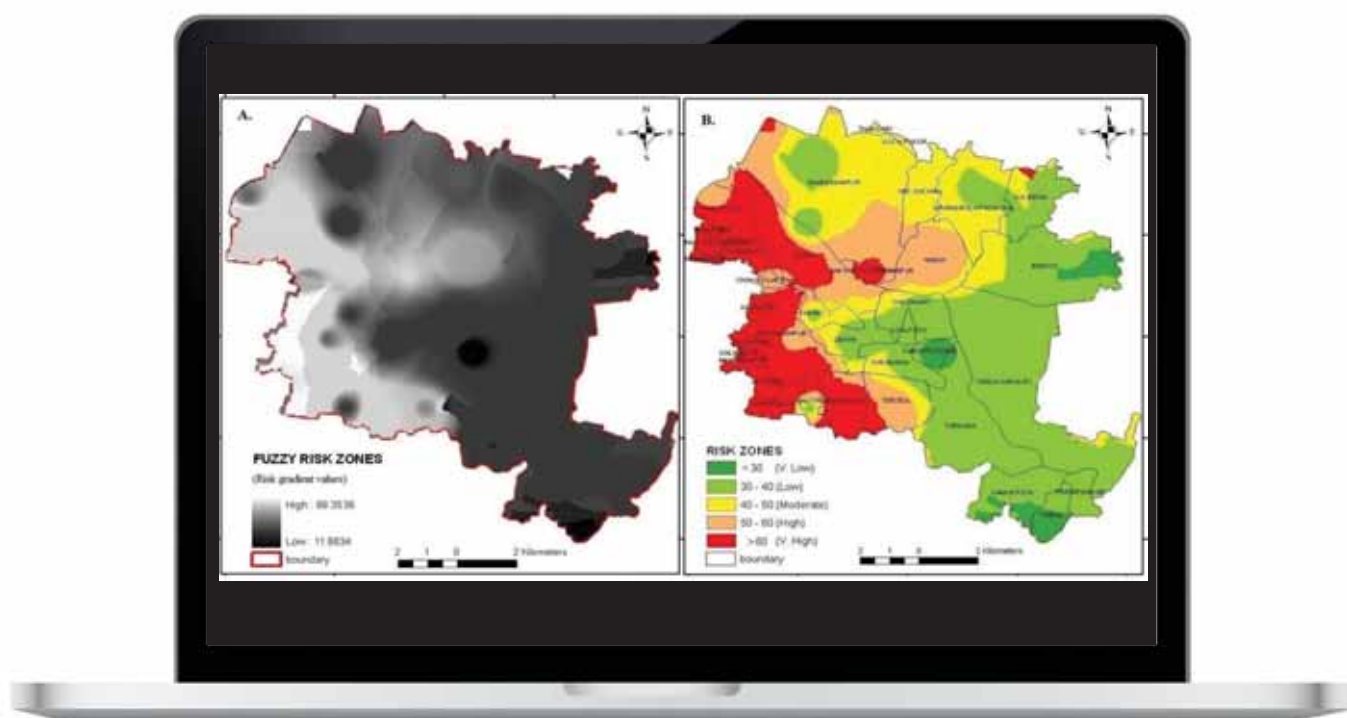
(A.) Fuzzy output of level of risk; (B.) Categorisation of risk zones superimposed by mouza boundaries.

The resultant risk map was validated so that the efficiency of the model can be justified. The generated EKW risk map with risk gradient was classified into five risk regions to make the process easier.
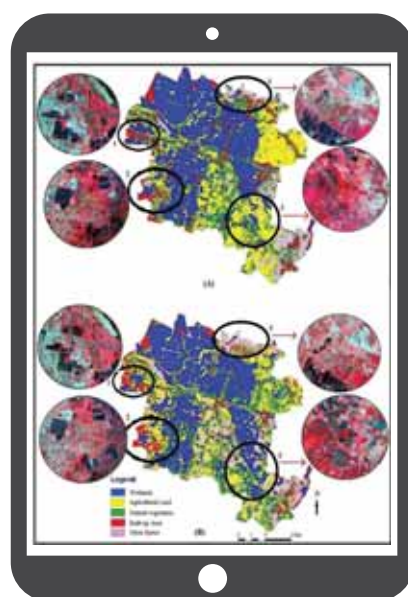
The classified Landsat 8 data of 2014 was compared with the IRS-P6 LISS III data of 2012 to detect the change in LULC of EKW (Fig. 4). Four regions can be identified where major changes had taken place in these two years. Significantly, two regions are in the very-high-risk zone, one in moderate-risk zone, and one in low-risk zone. In both the very-high-risk zone regions, the conversion of wetlands to other land-cover classes has taken place. For the region under moderate-risk zone, land under vegetated class in 2012 was converted to open-space class in 2014. Thus, cultivated or vegetated land is being left out as fallow or cultivable waste land. And in low-risk zone, agricultural land and open-space classes were converted to wetland class (between 2012 and 2014), showing conversion of land into water bodies. This indicates that the fuzzy-based risk assessment model has appropriately

Classified maps for (A) 2012 and (B) 2014; Changed portions in the insets.

captured the risk zones of EKW.

7.4. SUMMARY

The study applied Fuzzy Inference System to map the wetland conversion risk of EKW. Like many other geospatial entities, wetlands have fuzzy boundaries in both attribute space and geographic space. Fitting such entities and their risk factors into discrete categories with crisp boundaries induces uncertainties in the class assignments. Therefore, fuzzy logic has provided a simple way to capture and map the uncertainty or vagueness in natural resources boundaries. Various interpolation techniques available in the ArcGIS Spatial Analyst tool were a great help in this. The fuzzy inference-based decision support system for wetlands risk mapping presented here can be a useful tool for decision-makers involved in the planning and management of the ecosystem. ∎

What New Technologies are in Store for the **ArcGIS Enterprise 10.7.1 User?**

This year, ArcGIS Enterprise 10.7.1 introduced some amazing technology within its environment to help explore our geospatial world in new dimensions.

The ArcGIS Notebook server is one of the novel features on the ArcGIS platform.

WHAT IS ArcGIS NOTEBOOK SERVER?

The ArcGIS Notebook Server is a versatile web-based interface for powerful geospatial data analysis. Notebook allows you to perform analysis, automate workflows, and immediately visualise data and analysis results in the geographic context.

WHY ArcGIS NOTEBOOK SERVER?

- Works with Windows and Linux operating systems.

- No third-party application needed.

- Seamlessly integrates with your portal.

- Enriched with Python libraries.

- Codes and visualises maps simultaneously.

- Gives you the option to share your custom code with the world.

SUMMARY

The ArcGIS Notebook Server is a haven for geospatial developers. It provides an integrated platform to create, share, and run data science, data management, and administrative scripts. Notebook authors enjoy Esri's Python resources – ArcGIS API for Python and ArcPy – in addition to popular open-source analytical, statistical, and machine learning libraries. ArcGIS Notebook provides rich detail, all of it at your fingertips.
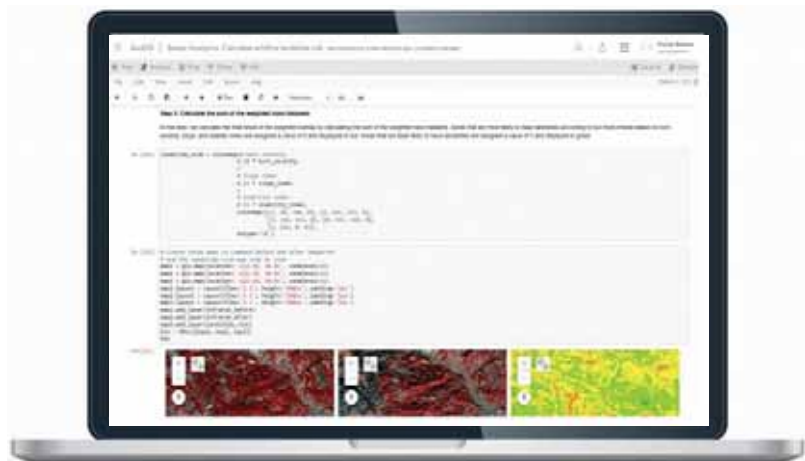
ArcGIS EXCALIBUR

Speaking of detail, the ArcGIS Excalibur is certainly an ArcGIS feature to watch out for. ArcGIS Excalibur is a project-based imagery application that updates and enhances image-based workflows through intuitive experience.

ArcGIS Excalibur makes image exploitation easy for users. View live updates of drone, aircraft, or satellite imagery along with authoritative geospatial, contextual and operational layers. Manage and assign imagery exploitation
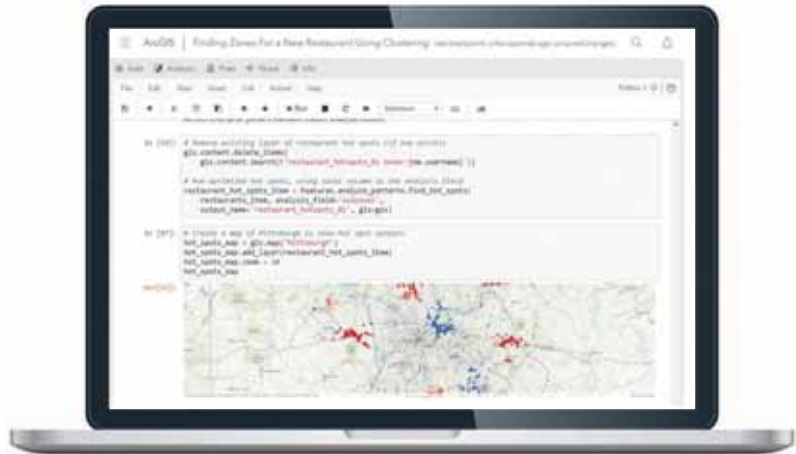
ArcGIS Notebook server helps to code and visualise data simultaneously, helping you lookup the most feasible sight for seeding business.

Help of ArcGIS Notebook server user can perform complex analysis with the help of Python code and visualize the result in a single frame.


ArcGIS Excalibur helps you simultaneously visualise and overlay live updates of aerial imagery.

Notebook authors enjoy Esri's Python resources – ArcGIS API for Python and ArcPy – in addition to popular open-source analytical, statistical, and machine learning libraries.

WHO NEEDS ArcGIS EXCALIBUR?

ArcGIS Excalibur is an invaluable tool for industries that require geospatial imagery, including:

- Architecture, Engineering, and Construction
- Banking
- Education
- Electric and Gas Utilities
- Health and Human Services
- Insurance
- Manufacturing
- Natural Resources
- Petroleum and Pipeline
- Public Safety
- Real Estate
- Retail
- Central, state, and local governments
- Telecommunications
- Transportation
- Water
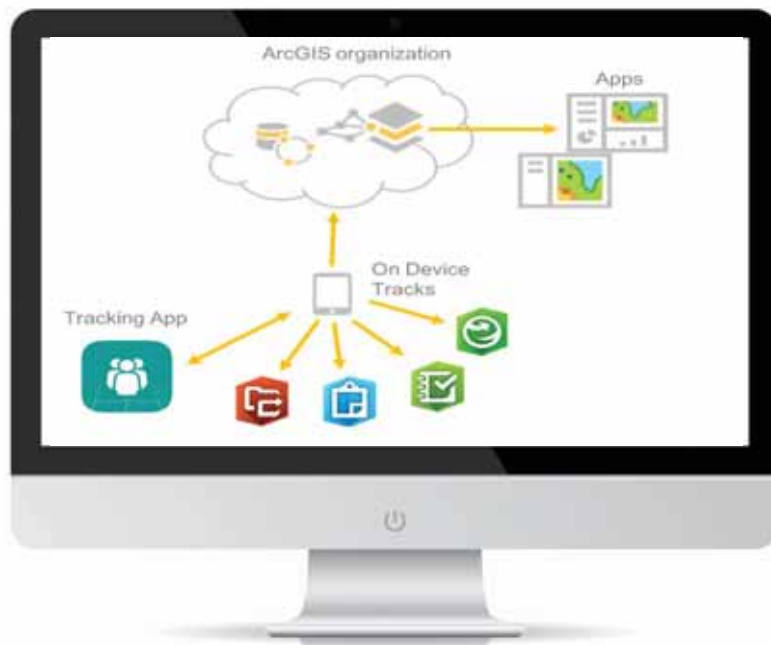
Tracker for ArcGIS helps collate field level activity, and apply field data to applications simultaneously. This helps identify gaps and data while on-the-go.

tasks across your organisation while leveraging the benefits of Esri Geospatial Cloud. Integrate ArcGIS Excalibur to your portal and mine your images intelligently. Compile, publish, share, and disseminate dynamic information products to consumers and devices in multiple formats.

ArcGIS Excalibur applies the power of timely geospatial intelligence to wide-ranging applications, including those as localise as road damage, traffic, or accidents.

ArcGIS Excalibur is a game-changer for analysts, imagery specialists, and managers, allowing them to collaborate and deliver timely geospatial intelligence to decision makers.

TRACKER FOR ArcGIS

The path-breaking Tracker for ArcGIS is another ArcGIS Enterprise application that can be used to record where users are and where they have been. The Tracker stores user locations as point features in a scalable spatiotemporal Big Data repository. User tracks are secure within the location tracking service – users see only their own tracks; they can access other user tracks and last known locations, and perform analysis on tracks with additional permissions.

Tracker for ArcGIS activates location tracking, using two applications: the Track Viewer web app and the Tracker for

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Geospatial technology gives you the location-based intelligence and spatial analysis you need to build and maintain a Smart City. With its 'Geospatial Analytics Tools & Platforms', Esri provides pre-emptive strategies and remedies that act as strong pillars of a Smart City.

GIS

Sustainable Urbanscape

GIS Enabled Resilient City

Smart Transportation

Smart Asset Management

Smart Urban Services

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ArcGIS mobile app.

The Track Viewer for web allows administrators to monitor track views, define which user tracks are included in the view, and who can view those tracks.

The Tracker for ArcGIS mobile app is designed to track locations in the background, while optimising battery use. The mobile app can track users even without a data connection. Users are in control of when they are and are not tracked.

TRACKER ARCHITECTURE

Benefit of using Tracker for ArcGIS

Homeless counts are but one of many situations where the Tracker for ArcGIS can improve the efficiency, safety, and coordination of tracked activities

The mobile app can track users even without a data connection. Mobile users are in control of when they are and are not tracked.

using the power of location.

WHAT ABOUT ArcGIS GEOANALYTICS?

Pivotal for Big Data processing and analysis capability, ArcGIS GeoAnalytics Server is a superior feature of the ArcGIS Enterprise 10.7.1. It provides a distributed computing framework that powers a collection of analysis tools capable of analysing large volumes of data. Aggregation, regression, detection, clustering, and much more help you visualise, understand, and act upon your Big Data. The GeoAnalytics Server helps you perceive insights – patterns, trends and anomalies - otherwise hidden in data.

The GeoAnalytics Server in ArcGIS 10.7.1 comes armed with 11 state-of-the-art Big Data

11 State-of-the-Art Big Data Analytics Tools

- Overlay Layers now supports new overlay operations (union, symmetric difference, and identity).

- Join Features supports proximate relationships geodesic distance.

- Clip Layer extracts input features from within specified polygons of interest.

- Dissolve Boundaries finds polygons that intersect or have the same field values, and merges them to form a single polygon.

- Enrich from Multi-Variable Grid appends attributes from a multivariable grid layer onto a point layer.

- Forest-based Classification and Regression creates models and generates predictions via an adaptation of a

supervised machine learning method – Leo Breiman's random forest algorithm.

- Generalized Linear Regression generates predictions and models of a dependent variable as related to a set of explanatory variables.

- Merge Layers integrates all the features of two separate layers into a single output layer.

- Describe Dataset provides a summary and sample of your Big Data.

- Find Point Clusters are equipped to apply the HDBSCAN algorithm.

- Calculate Field, Detect Incidents, and Reconstruct Tracks support new time-splitting options.

The GeoAnalytics Server helps you perceive insights – patterns, trends and anomalies – otherwise hidden in data.

analytics tools that can compute, analyse and visualise data even faster.

ArcGIS Indoors

No discussion of ArcGIS novelty is complete without the brand-new ArcGIS Indoors – a game-changer in the area of indoor mapping.

ArcGIS Indoors is a complete system for indoor mapping, with the power to create a connected workplace. Indoors generates a common operating picture for executives, workplace services personnel, other employees, and visitors to understand, manage, and use their workplace environment. An extended version of ArcGIS Pro, native web and mobile applications, including one for iOS, and an indoor information model help ArcGIS Indoors create, customise, share, and apply workplace maps and location data. This helps you manage workplace operations and build a comfortable environment for your people.

WHAT CAN USERS DO WITH ArcGIS Indoors?

Indoor mapping
Allow personnel across the workplace to access specifically curated indoor maps using unlimited user access and identity-based permissions.

Indoor wayfinding
Improve on-site mobility for employees, contractors, and even visitors using Indoors resource exploration and navigation.

Indoor location tracking
Capture real-time indoor location information for easy navigation and resource monitoring, allocation, and management.

Indoor Positioning System (IPS)
Experience indoor positioning with the same level of comfort you are used to outdoors. ∎

ArcGIS Indoors streamlines way-finding within large complexes, giving users the luxury of specifically curated maps and personalised navigation.

GIS HERALDS
HARVEST HIGH

GIS holds the key to viable solutions for agriculture at a time when a host of factors, including climate change and urbanisation, emerge as real and present threats to feeding the world.

Today, users demand an extremely simple and streamlined data-collection user experience, while on the go. ArcGIS QuickCapture is specifically designed to effectively support this through at-speed and rapid data collection workflows. Need a plan to save time? ArcGIS QuickCapture helps you send data back to the office for analysis in real-time, eliminating time spent on manually processing handwritten notes. At-speed asset inventories, aerial surveys, pipeline patrols, quick on-the-go inspections, or crop scouting are some of the workflows where ArcGIS QuickCapture excels.

The search for agrarian justice led to the Green Revolution in the seventies, with significant investment in research, infrastructure and extension services across South Asia. Flash forward fifty years, and we are looking at a paradigm shift in agricultural operations. A shift that will be powered by real-time spatial analysis, Internet of Things, and Big Data, all tied together through customized, interactive maps and apps. A shift that holds out the promise

of sustainability to future generations.

Increased urbanization is the way of the future; between now and 2050, estimates peg a net addition of 2.4 billion people to towns and cities. In 2018, the Gaon Bandh and Kisan Mukti Morcha heralded a sea change in Indian agriculture - a new national consciousness among farmers. The plethora of hash-tags that accompanied these marches exhibited the centrality of agrarian justice, even within the urban Indian's imagination. As global scenarios transform and mutate at a rapid pace, this quest for agrarian justice – from plough to plate – is set to become a central theme in technology as well.

The World Government Summit 2018 has listed four main challenges that face the 'legacy agriculture model' in meeting demands of a largely urban future: demographics, scarcity of natural resources, climate change, and food waste. Smallholders (cultivating in plots below 2 hectares) are at the vanguard of the associated socio-economic, structural and institutional challenges that face agriculture in the coming years. Concentrated in China, India, Indonesia, Bangladesh and Vietnam, smallholders produce nearly 80% of the food consumed in the developing world, and feed one-third of the global population. The specialized and contextual solutions that are being demanded do not merely depend on information; they require a powerful database that can integrate a systems-thinking approach into agriculture; leverage the power of cloud computing; understand relations between different trends and sectors; and, arrive at reasonable predictions that can mitigate risk and vulnerability.

USING BIG DATA TO THINK BIG

In 2017, India's NITI Aayog put the onus on digital and precision agriculture, through Pradhan Mantri Krishi Sinchai Yojana (PMKSY), Soil Health Cards, Electronic National Agricultural Market (eNAM), etc. Precision agriculture is the ability to manage land by the square meter instead of the square mile. As developing countries push for precision, it is estimated that the average farm will generate 4.1 million data points daily in 2050, up from 190,000 in 2014. This is but a harbinger of the immense data revolution that is set to storm agriculture. The level of data that will be collated globally requires a solution beyond mere observation. In this background, it is important that we move past simply measuring and analysing data to understand and solve some of the biggest problems facing the world.

Cross-country and cross-disciplinary empirical investigations become critical in precision agriculture. Esri recognises that precision can only be an outcome of an Edge-IoT platform-Enterprise system that aggregates granular, real-time data from a variety of sources - environmental sensors in the field; NDVI images from UAVs; sensors on field equipment; weather forecast data; and soil databases. To achieve economies of scale – an advantage lacking in Indian agriculture so far – it becomes necessary to aggregate data, streamline workflows, eliminate redundancy, and manage inputs (land/labour/capital).

At Esri, we have steadily stepped up our game to meet these demands of the future. While our Living Atlas of the World works at the top of the pyramid to ensure a central repository of global spatial data, our ArcGIS QuickCapture works from the grassroots up. From sorghum to satellites, maps are steadily becoming a common language across organizations. Esri is here to help.

THE SCIENCE OF WHERE FOR PEOPLE

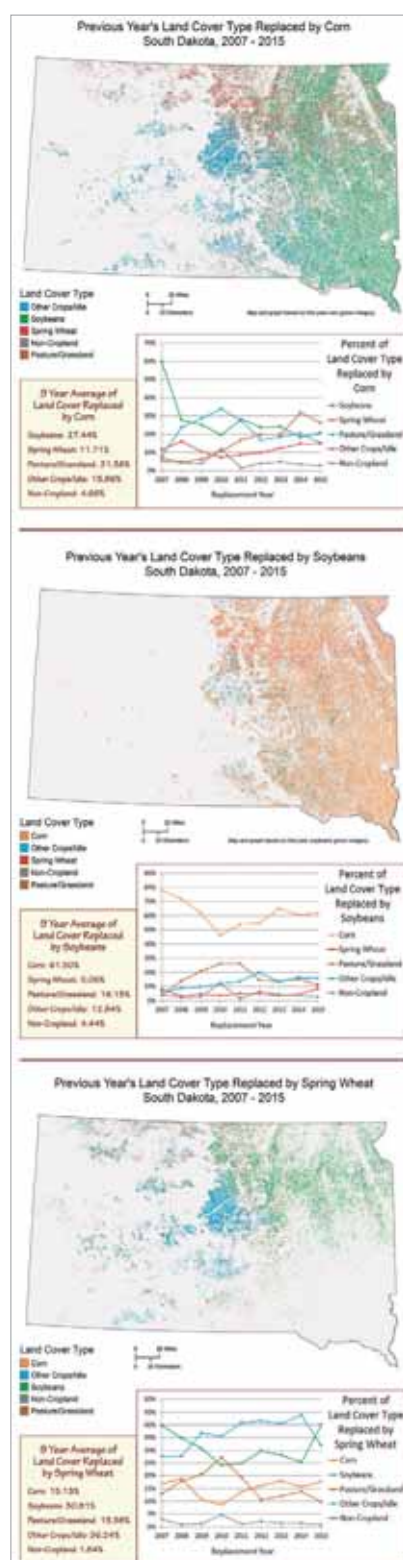Even with the rapid pace of economic development, agriculture has remained the

"The new world needs a new nervous system — an intelligent and responsive platform to create more understanding, collaboration and action. Geography is the only way forward."

Jack Dangermond, Founder and President, Esri Inc.

mainstay of the nearly 60% of the Indian population. While projecting a large working-age cohort in future, researchers warn that the flexibility of future agricultural models may be marred by a man-power retreat from the non-remunerative conditions of legacy agriculture. As diets diversify, the skill sets of agricultural labourers that cultivate them will also require specialization. GIS can be used to coordinate and direct labour availability for agriculture, eliminating challenges of disguised unemployment and distress migration.

In the post-GR period, prosperity turned large segments of farmers in Punjab and Haryana into farm 'managers'; without outside labour, the agricultural sector here faces danger of collapse. Farmers that can visualize labourers as data points can plan crop rotations based on labour availability and location. We have already laid the foundations for such operations through the 'Agricultural Workers' layer in Esri's Living Atlas of the World.

MHRD advocates the "Science of Delivery" to increase, and address disparity, of rural incomes; it involves developing a technology spine that leverages Aadhaar IndiaStack, GIS, and SDI supported by hybrid cloud systems. Esri's i-DGIS solution for National Dairy Development Board (NDDB) thinks along these lines. i-DGIS facilitates convergence planning among multiple stakeholders including Milk Unions/Federations, the Department of Animal

Previous Year's Land Cover Type Replaced by Corn
South Dakota, 2007 - 2015

Previous Year's Land Cover Type Replaced by Soybeans
South Dakota, 2007 - 2015

Previous Year's Land Cover Type Replaced by Spring Wheat
South Dakota, 2007 - 2015

Husbandry, and Livestock Development Boards of state governments. It uses a simple GUI that enables monitoring and planning of activities like milk procurement, ration balancing,

fodder development, artificial insemination etc. i-DGIS helped replace a layman's solution conducted on paper maps with an integrated database that included information on citizens, livestock and land use/land cover. i-DGIS integrated data and graphical information in multiple ways that churn gigabytes of actionable intelligence.

India's population growth is forecasted to surpass China's over the next two decades, making it the fastest-growing nation in the world. To leverage the potential value of such large populations, and to respond to diverse problems with flexible solutions, requires decentralised data logging. Scientific crowdsourcing has been around since 2014, when the Consultative Group on International Agriculture Research (CGIAR), an organization that coordinates agricultural research internationally, set up the Roots, Tubers and Bananas (RTB) for Food Security and Income program. The RTB program is supported by an application called RTB Maps which aggregates spatial imagery to show crop distribution, desolate areas, pest and disease locations, and socio-economic data. RTB Maps was built with ArcGIS server technology from Esri.

The 2030 Agenda for Sustainable Development embodies a vision that goes beyond the divide of 'developed' and 'developing' countries. We at Esri salute this sentiment; as a common spatial language that utilises earth observation emerges, no person's data can be dismissed as another person's noise.

THE SCIENCE OF WHERE FOR ECOLOGY

"In the next 20 years we have to do the Green Revolution again in terms of the increase in production. We've got to do it in half the time and with less energy and inputs – and all the easy stuff has already been achieved."

According to the UN, 91% of all disasters between 1998 and 2017 were caused by floods, storms, droughts, heat-waves and other extreme weather events. We are also staring down the barrel of global warming; South Korean studies have documented how rising temperatures have promoted harmful pests that cause massive damage to horticulture.

" In the next 20 years we have to do the Green Revolution again in terms of the increase in production. We've got to do it in half the time and with less energy and inputs – and all the easy stuff has already been achieved. "

Professor John Crawford,
Integrated Solutions Lab Flagship Leader at Rothamsted Research

Globally, by 2030, UNFAO estimates that 653 million people could face malnourishment under a business-as-usual scenario. In the post-GR world, cultivation has skewed in favour of rice and wheat due to various input subsidies. Steady mono-cropping has resulted in pest build-up, overuse of fertilisers, and cropping incompatible with agro-climatic zones. This, in turn, reduces resilience to weather hazards, increases water stress and degrades ecosystems. Significantly, crop diversification is mandatory not just to counter malnutrition, but also for climate resilience, ecological stability and efficient natural resource use. GIS hold the solution in building a systems approach into government schemes - like PM-AASHA - that are pushing for crop diversification in favour of pulses. It can ensure that the imperative of nourishment is

not at the cost of ecosystem damage. If programmes such as GoI's Integrated Watershed Management Programme (IWMP) are to truly succeed, they require spatial analysis that goes above and beyond political boundaries.

Given these contexts, Esri foresees the need to think of future spatial patterns in terms of historical imagery. Global earth observation projects are helping monitor the way the Earth's landscape is changing; they provide a valuable archive for the future. Agriculture and Agri-Food Canada (AAFC) is a government organization that tapped into the capabilities of ArcGIS Online to help producers make decisions. The organization launched UMAP, a self-service, cloud-based portal, where users could combine data such as annual crop inventories, historic crop yield, and production statistics, with interoperable data from other organizations and third parties such as Esri; the Land Use app is a part of this suite, and allows users to analyse changes in land use across Canada. For producers looking to rent, the Land Use app showed which crops have been planted in previous years; it has since allowed producers to make the most effective and environmentally conscientious decision about which land to farm and what to cultivate on it.

The Conservation Effects Assesment Project (CEAP) indexes soil vulnerability to help integrate soil conservation, agricultural and marine pollution-based responses for a more coherent policy response.

CEAP Soil Vulnerability Index for Cultivated Cropland (SVI-cc) Leaching, Managed

CEAP Soil Vulnerability Index for Cultivated Cropland (SVI-cc) Leaching

Courtesy of USDA-NRCS.

CEAP Soil Vulnerability Index for Cultivated Cropland (SVI-cc) Runoff
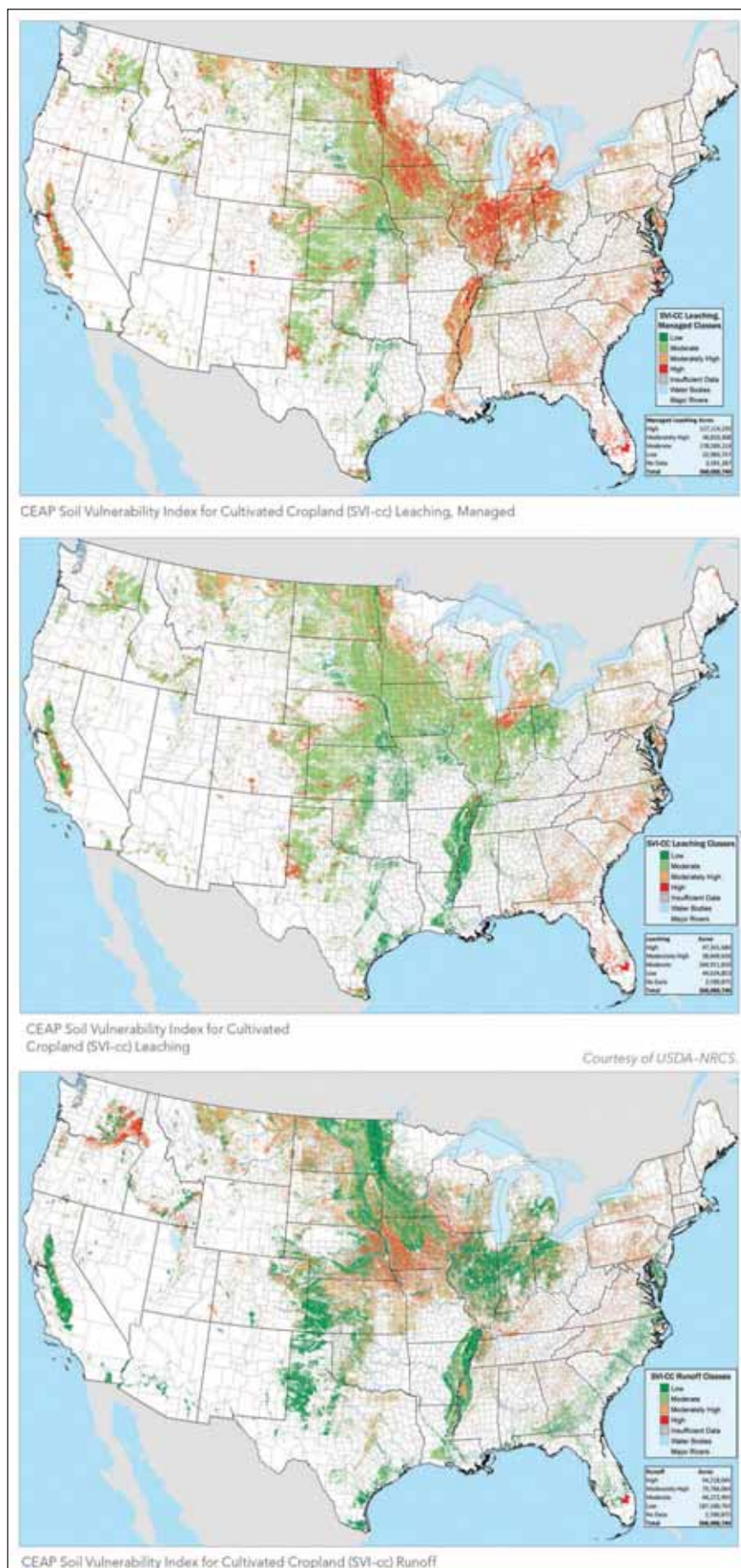
THE SCIENCE OF WHERE FOR CLIMATE

20 years after the Rio Declaration, Rio+20 pushed for new geospatial technologies, satellite remote sensing, geographic information systems, and global positioning systems for a comprehensive worldwide assessment of environmental conditions. Indian agricultural land alone has 15 agro-ecologies and 46 of 60 different global soil types; this uniquely positions Esri's already robust database to design, develop and deliver solutions for producers that will have global applications. The USDA CropScape application that uses the Esri database does just this - it enables farmers to see what crops are growing where and how much, thereby helping farmers plan what to produce.

Indian agriculture and livestock accounts for 18% of gross national emissions; it is the third-highest contributor after energy and industry. As Indian incomes grow, a dietary transition toward higher consumption of meat, fruits and vegetables is likely. Increasingly, these demands will be met through imports; lengthening distances between plough and plate further raise 'the resource-, energy-, and emission-intensity of the global food system'. The role of GIS in marketing chains has gained significance with these increasing lengths. A niche opportunity has been created for data-sensing companies; precision agriculture start-ups such as AgNext have captured several of the key, controllable input factors of
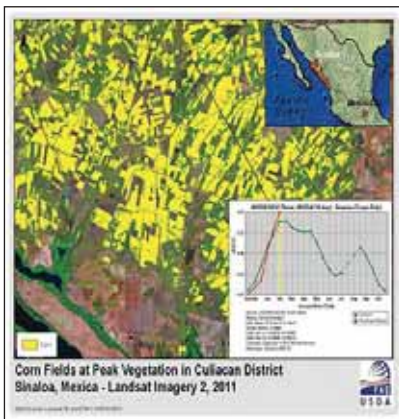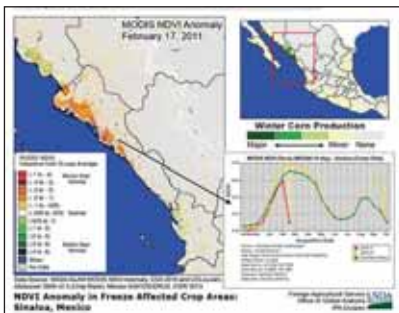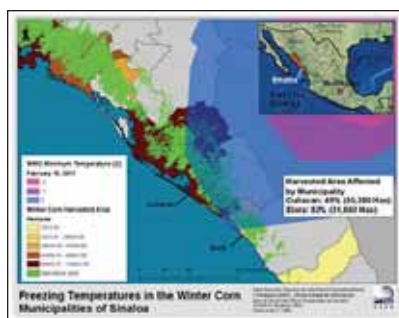
The USDA's Risk Management Agency has been using the Landsat 8 satellite since 2013 to determine whether damage to crops after a flood or other weather event has occurred.

production (harvest, planting, application, and irrigation data) to provide management decision support to producers. At the top of the pyramid, EU's Copernicus programme has cleared the table for many space-based start-ups to take big steps forward, thanks to its free and open data programme. We stand at a crossroads of human development; here, Esri aims to tie together different sets of background data, to allow teams to gain unprecedented powers

of classification, interpretation, prediction, and forensics.

THE SCIENCE OF WHERE FOR HUNGER

Through input-intensive legacy agriculture, India's trend growth rates achieved significant levels in food production; however, the growth in per-capita food production has been negative, indicating worsening food availability. Indian studies show that for every 1°C rise in temperature, wheat production will go down by four to five million tonnes. Surprisingly, on the other hand, it takes a land mass larger than China to grow food that ultimately goes uneaten – food that accounts for 25 per cent of all fresh water consumption globally. These massive market inefficiencies defy FAO's warnings of global hunger. GIS can play a major role in enhancing accountability, transparency, and the reach of e-governance to ensure three-way robust communication between the public, government and corporation. Crop insurance in the aftermath of a disaster is one such example; GIS capabilities have been used to streamline pay-outs to beneficiaries, while minimising fraudulent claims of crop losses. The USDA's Risk Management Agency has been using the Landsat 8 satellite since 2013 to determine whether damage to crops after a flood or other weather event has actually occurred.

Consumer demand for organic, GMO-and antibiotic-free food is often dampened by news of fraudulent labelling; it throws a wrench in global supply systems,

and the farmers that depend on them. GIS can allow the smallest transactions – at farm, warehouse, or factory – to be monitored and communicated across the entire supply chain, when paired with IoT technologies, such as sensors and RFID tags. For example, Olio has an app that connects people with their neighbours and local shops, allowing surplus food to be shared, rather than be discarded. VegScape - another USDA Web GIS application - provides weekly maps, and displays crop health based on infrared data from NASA's MODIS satellite.

The significant spatial and technical challenges present in Sub-Saharan Africa and Southern Asia have prevented the use of remote sensing technology in many areas. These data lacunae need to be tapped at the grassroots through scientific crowdsourcing, which can be supported by applications like ArcGIS QuickCature, GeoAnalytics and Tracker for ArcGIS. Most importantly, the challenge of the future is not limited to changing scenarios but also changing data. As more data is reported in a decentralized manner, and findings logged and analysed, dynamic policy-making will be required to keep abreast of the idea of 'sustainability'. Esri

> ## " Let the dataset change your mindset. "
>
> **Lt. Hans Rosling,**
> Chairman, Gapminder Foundation

aims to be in the driving seat and ahead of the curve when sustainability converts from being merely a watchword to a relevant – and moving – bulls-eye.

THE SCIENCE OF WHERE FOR THE FUTURE

In 2017, the UNFAO explicitly stated the relevance of reliable and timely geospatial information on natural resources, environmental conditions and their changes as one of the prerequisites of sustainable agricultural development. While global policy is pushing towards technological solutions, a large part of agriculture in the developing world is being conducted in rural areas that have reported high work participation rates among those above 60 years of age. Challenges are also expected from a steadily globalizing world. Isolated solutions in subsistence-oriented agriculture are insufficient

to tackle new challenges of intellectual property rights; animal welfare; sanitary and phyto-sanitary measures, etc.

Esri aims to ensure that the benefits of spatial thinking become accessible, even to technologically-handicapped populations, by extending the power of mapping to anyone who wants it. Raising competencies in GIS can help capture the economy of scale that eludes agriculture. As more people begin thinking spatially and visually through the use of coherently tied datasets, Esri's databases hope to become a container for really creative ways of re-conceiving and redefining problems in ways that are relevant for those in a particular area, while ensuring that the solutions do not outsource problems elsewhere. The Science of Where is geared up to enable people worldwide to 'work collaboratively towards creating a better world'.

Staggering inconsistencies between ground realities and data availability, technological diffusion, national priorities, environmental concerns and livelihood demands defy a conventional agricultural solution. At the Esri User Conference in San Diego this year, President Jack Dangermond enjoined communities and called for "vision and willingness on part of individuals to envision what's possible by learning, sharing and collaborating, with a passion to create understanding and create a better world." This is what Esri India is looking forward to – harnessing the potential of spatial analysis to power sustainable agriculture. ∎

SpecX assesses agroproducts quickly using scientific parameters such as protein, moisture, SNF and curcumin levels.

AgNext and Esri India's Data Solutions for an Efficient Agri-value Chain

India's agricultural productivity has for long been hobbled by the fragmentation of land holdings. Since 2018, the Government of India has promoted contract farming as part of policy. This aims to mitigate price risk and market uncertainties through advance agreements, encourage the entry of private players into the farm sector, and foster a culture of precision agriculture.

In the same year, India's Vice President, Mr. M. Venkaiah Naidu, also reaffirmed that precision agriculture was an extremely vital strategy in the country's second Green Revolution, actively promoted via schemes such as PMKSY (Per Drop More Crop) and the Model Act on Contract Farming.

However, 8 in 10 Indian agriculturists are classified as "small farmers", owning up to only 2 hectares of land. In this highly non-standardised environment of cultivation, it has been a daunting task to leverage collectivisation, from pre-production to post-harvest marketing.

AgNext has been quick to realise that the agricultural value chain provides fertile first-market-opportunities for many advanced technologies that can ensure quality and precision in farming, and gain remunerative prices for the farmer.

ABOUT AgNext

AgNext is an agricultural sensing and solutions company, and a recipient of many national-level awards, including the accelerator programme of NAARM and CIIE; Incubation, at IIT Kharagpur; and Best Upcoming Startup Award by Assocham, India. AgNext aims at data solutions to raise efficiency across the agricultural supply chain.

> **❝ The Esri Dashboard was a crucial pivot in the entire system, since creating separate dashboards for a start-up like AgNext would not have been an easy task. ❞**

Manik Verma, Business Officer, AgNext

The significant size of the geographies to be covered was a major factor in AgNext choosing the Esri platform. Mr. Manik Verma, Business Officer at AgNext, said: "Esri's platform has enabled us to develop the whole ecosystem, making it possible to easily assess the large quantity of data generated per farmer. We have started building quality maps for different commodities to understand what quality of produce comes from which areas in India. Currently, actions in agriculture are highly diffused. This centralised data could therefore help in policy making."

In collaboration with Esri India, AgNext has developed unique solutions for spectral and temporal analysis solutions. As a network partner, Esri collaborates with AgNext on a day-to-day basis to troubleshoot technical issues in real-time. These solutions leverage Esri's Science of "Where", and append them to AgNext's Sciences of "What" and "When".

SPECX: THE SCIENCE OF WHAT

SpecX is a nifty hand-held device that combines computer vision with spectroscopy to accurately assess the chemical and physical parameters of an agro-commodity. The quality of produce is assessed quickly using scientific parameters such as protein, moisture, SNF, and curcumin levels.

Lack of a portable quality assessment solution often leads to trader-driven prices in the market. SpecX provides accurate results over the mobile phone. This portability is enhanced by an individual API that connects and transmits information to a centralised larger-level database. The device connects to AgNext's server through ArcGIS's remotely accessible geo-event server; AgNext's server is then used as a data point. This feature has since become a USP for the company.

SpecX is currently being implemented successfully for assaying at eNAM mandis. Additionally, the technology solution is widely used by commodity exchange companies, warehousing corporations, agro-processing companies etc.

SENSENEXT: THE SCIENCE OF WHEN

SenseNext is a suite of IoT sensors employed by agri-businesses and warehousing corporations for real-time monitoring of farm land. Deviations from quality and disruptions in the agri-value chain are identified on a real-time basis and communicated to various stakeholders through Esri's

Benefits

- Fulfils market demand for a rapid quality-assessment device that is portable; the SpecX arsenal has been employed against food adulteration, especially in areas such as Haryana, where 70% of milk was reported adulterated.

- SpecX requires minimal technical expertise and functions predominantly as a point-and-shoot device.

- Rapid quality assessment and uploading to a centralised database (via APIs) provide farmers with direct market linkage. This increases their bargaining power and price realisation.

- In e-procurement and e-warehousing market models, SpecX helps reduce intermediaries and puts farmers in charge of their produce and its value. It allows farmers to access markets facing a glut in certain crops, and prevents distress sale within a particular area.

- In future, SpecX could find use in service-level benchmarking, allowing farmers to invest more efficiently in production, and B2B agri-food businesses to improve bulk procurement of agri-commodities.

SpecX is widely used by commodity exchange companies, warehousing corporations, and agro-processing companies to verify the quality of produce.

dashboard and periodic alerts over the smartphone.

Mr. Manik Verma reiterates how the Esri dashboard was a crucial pivot in the entire solution, since "creating separate dashboards for a start-up like AgNext would not have been an easy task". Esri's dashboard was dynamic enough to allow AgNext to push through various mobile apps and widgets. This flexibility aided widget development that was specifically iterated to suit the AgNext clientele.

Combined, AgNext and Esri provide a formidable digital platform through which growers and food processors can improve the efficiency of cropping, monitor quality of agro-commodities, improve market access for farmers, and reduce market intermediaries. ∎

Benefits

- SenseNext continuously relays data from farms to key stakeholders, allowing for quality control in cropping, harvest, and post-harvest management.

- It works as a simple plug-and-play IoT solution that delivers data instantaneously upon installation.

- Scientific cropping — as required to ensure fine leaf count for tea, for example — is ensured.

- The efficiency of post-harvest quality management — especially for temperature-sensitive agri-commodities like milk — is scientifically ensured.

- Immediate alerts about storage deviations that can lead to deterioration of quality in the agri-value chain help rectify issues immediately; they also provide a scientific basis for valuation of agri-commodities.

- The solution has found widespread application in plantation agriculture, especially in tea and other cash crops, where one-on-one evaluation of crop quality is time consuming and man-power intensive. Companies have implemented SenseNext, in tandem with SpecX, in various stages of its contract farming programme.

- The solution is being implemented successfully at cold stores, chillers, refrigerators etc. for agri-food businesses to continuously monitor deviations from optimum parameters. Alerts are sent through email and SMS in case of deviations that may lead to degradation of quality.

Use the Layer Showcase App to Create and View 2D and 3D Maps
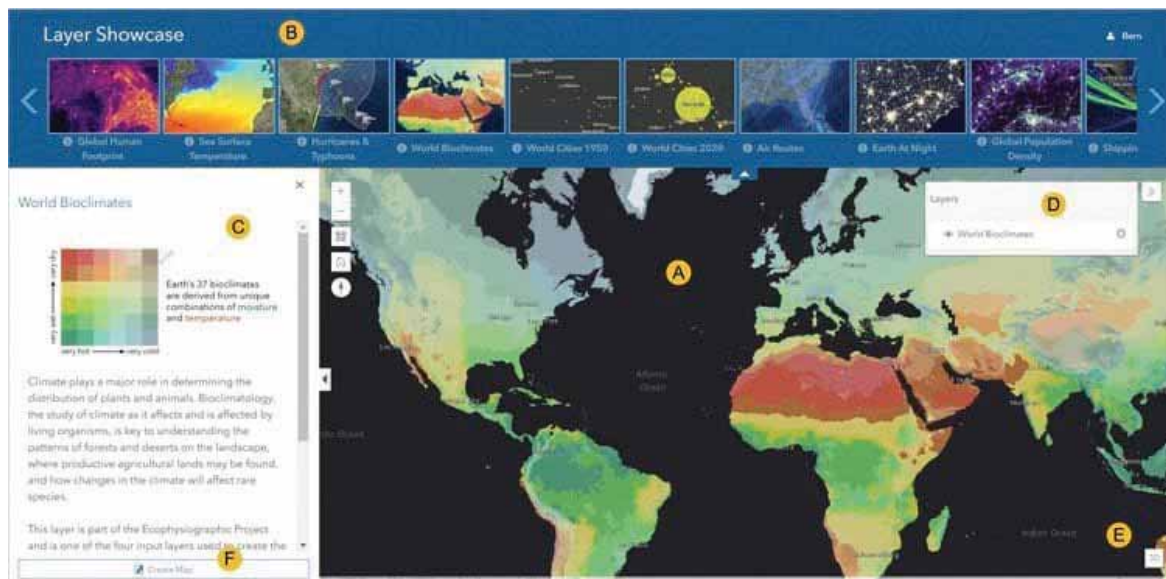
A retractable ribbon displays a gallery of layer types, which can be selected, overlaid, or displayed simultaneously to visualise a comprehensive data set.

L ayer Showcase is a group-based, configurable app that you can create in ArcGIS Online. It gives you the ability to display a gallery of layers found within a group. You can display the layers in a ribbon and add them to a map or globe.

This app is handy because you can share it with colleagues within your organisation, giving them the ability to explore layer-based content and, if they wish, quickly create a map or scene based on the layers that have been added to the view.

Layer Showcase includes several easily configurable components, including the following:

- The map, authored by selecting layers from the ribbon.
- A retractable ribbon that displays the layers found in the group, giving viewers the ability to add layers to the map.
- A retractable side panel that displays either the group description when you first open the app or

the layer item description when a layer is added to the map.
- The table of contents, used to toggle layer order and visibility, adjust transparency, and display a legend.
- A 2D/3D map toggle.
- A Create Map button that you can use to create a map or scene once layers have been added.

MAKE A LAYER SHOWCASE

Follow these steps to make and share your own Layer Showcase.

Step 1. Create a group and add the layers you want to the group. Make sure that you include a complete description and a good thumbnail. The Earth Layers

sample group is used in the steps below. View the group description and review the contents and their descriptions to understand how they affect the app.

Step 2. Review group and content sharing settings. Click the group Settings tab.
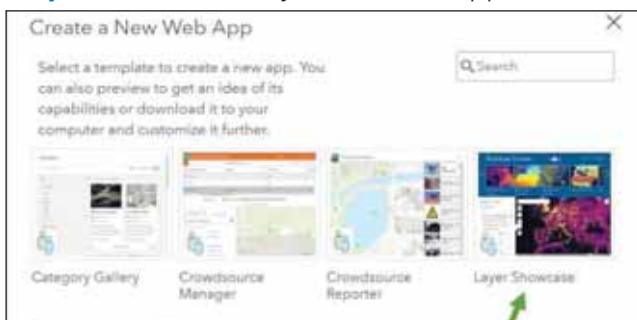

Review the list under Who can view this group? If you want the public to have access, check Everyone (public). Alternatively, you can limit access to people who work in your organisation or to group members.

Step 4. In the Share dialogue box, click Create a Web App.

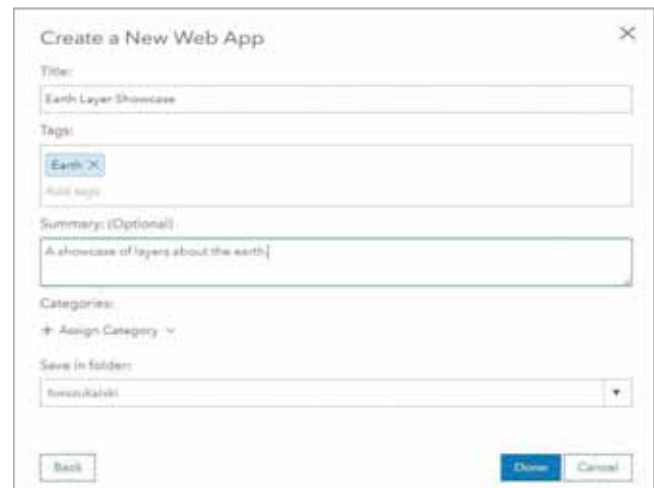
Step 5. Choose the Layer Showcase app.


Step 6. Click CREATE WEB APP.

Layer Showcase encourages employees to author maps and scenes from preselected content.

Step 7. Enter a title and any tags, add a summary if you choose, then click Done. This opens the configuration panels for the app.

Step 8. Configure the app as desired. Click the General, Theme, and Options tabs to make changes. Click Save to apply your changes; they will be seen in the preview on the configuration panel. When finished, click Close.
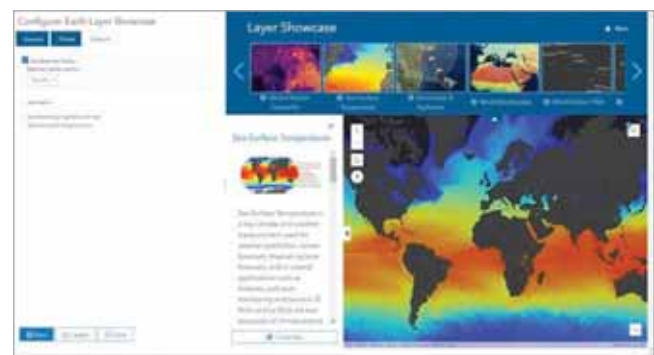
Sharing content in a Lawyer Showcase offers a great alternative to Map Viewer or Scene Viewer, especially for those who are not GIS experts, to author a map or scene from preselected content. ∎

GIS IN SHELLFISH FARMS

Tracing Each Oyster from
Tide to Table

By Caitlyn Raines
Maritime Project Manager, Esri Inc.

The largest shellfish producer in the US, a fifth-generation family-owned operation, has brought about a digital transformation using location science and mobile apps to improve its products, share knowledge, and protect its people and land.

Taylor Shellfish Farms, the largest shellfish producer in the US, recently added a genetics programme. Rising ocean acidity, and the need to improve the resilience of the clams and oysters it raises, helped drive this decision.

Starting 2005, the company began to feel the impact of acidity on its 30 farms, which span 10,000 acres of tidelands in the Pacific Northwest. Hatcheries and wild oysters across the whole region saw a dramatic die-off, estimated in billions. By 2008, production at its hatcheries had dropped 60 percent.

After years of uncertainty, oceanographers made the link to more corrosive acidic waters at higher levels in the water column. Acidification robs young oysters of the minerals they need to make their shells. Without abundant materials, the oysters work too hard, exhausting themselves and become prone to disease and die-off.

Hatcheries have invested in high-tech pH sensors to track and cut down the acidity of the ocean water they pump into their operations. Awareness helped them to quickly change practices, leading to an oyster rebound.

The ordeal sowed doubts about the long-term viability of the industry. Taylor has heeded this warning, embracing technology for clarity on changing conditions and to add resiliency to its operations.

The company's digital transformation is unfolding against a backdrop of growing demand and reduced output from wild fisheries. This puts aquaculture at the forefront of sustainable seafood production to feed a growing population.

TRACING OYSTERS

Taylor, a fifth-generation family-owned aquaculture operation based in Shelton, Washington, has steadily expanded its scale and scope. More recently, it has added hatcheries and its own oyster bars to directly sell to customers.

KEY TAKEAWAYS

- Apps and maps provide traceability across each operational stage of production.

- Adaptability requires complete understanding of operations.

- Digital transformation gets bolstered by ease of use.

Survey123 for ArcGIS aids field data collection, such as reports of shoreline debris or presence of herring spawn. Collector for ArcGIS was then used to update operational data about farm beds.

> "We can compare farm to farm, understand the techniques that lead to improvements, quantify that value, and push the best techniques to other farms."

Nyle Taylor,
Farm Project Coordinator,
Taylor Shellfish Farms

The journey of each shellfish starts in the hatcheries where Taylor breeds oysters, clams and geoduck. These "seeds" are then planted on its many tidal beaches, where the shellfish are stewarded until maturity. The shellfish are then harvested and processed. Finally, the company distributes the shellfish, bringing it to market and to the tables in its oyster bars.

Apps to keep track of each farm bed's contents and maturity are central to the genetics programme. Taylor aims to add traceability to this awareness, with the benefit of being able to correlate the farm practices in each oyster's upbringing. This will help Taylor with the nature or nurture questions.

This approach combines human sensors, who are experts in shellfish quality, with technology that aggregates information on what happened where. GIS provides this backbone of capability, and apps accessible anywhere are what farmers use to inform the system.

With knowledge of conditions and lineage, Taylor staff can pick the best offspring, looking for resilience to acidity, growth rates, appearance, and taste. "We grow enough oysters that a 2 or 3 percent improvement in survival has real value," said Nyle Taylor, Farm Project Coordinator and a fifth-generation family member.

Taylor has created surveys in English, Spanish and Khmer to make data collection a habit among a diverse crew.

SHARING KNOWLEDGE

This increased awareness starts in the hands of each farmer. The company provides apps that its farmers and fieldworkers use to track operations on all the farms, from planting the seed to harvest. These apps communicate with a cloud-based GIS, which provides the ability to visualise and analyse the data to uncover inefficiencies.

"We can compare farm to farm, understand the techniques that lead to improvements, quantify that value, and push the best techniques to other farms," Taylor said. Apps also help keep track of inventories, budgets, and all operational details.

The company must comply with regulations at the local, state and federal levels that require many permits, and most permits require a map. For years, the company would submit hand-drawn maps for every permit, but this changed when it hired Erin Ewald as Assistant Director of Regulatory and Environmental Compliance. Ewald quickly put her experience with GIS to work for maintaining maps of farm beds. She managed and updated maps with GIS, and then made this data mobile. "Now, we can compile information and push it to the right people," Taylor said.

Easy-to-use apps are a critical component that make this transformation possible. "These apps are so straightforward that our farmers see the benefit," Taylor said.

Drones allow the company to capture farm beds at low tide with a clear understanding of elevation, a critical detail to locate the beds at optimum depth for farming each species.

STEWARDS OF LAND AND PEOPLE

Taylor has adopted environmental processes to make sure that the natural environment in Puget Sound, including the salmon and forage fish species around their farms, are not harmed.

The company prides itself on its long history of environmentalism and has got the only Aquaculture Stewardship Council certification in the US, which designates its shellfish are farmed responsibly.

Taylor's leadership also thinks about its people and its land for the long term. "Sustainability isn't just about the environment for us," Taylor said. "It's also about operating responsibly with our employees and in our communities. Paying living wages and providing benefits are important to us, as is making sure our workplace is safe."

Recently, one of their farm directors suffered memory loss following a car accident. The mobile apps have provided the manager with a backup of all the information about his farm, and the assurance that he can pull up any detail at any time. "We've reached a size where having the information in everybody's heads is not the best way of doing things," said Taylor. "Our digital transformation has allowed us to bring each farmer's knowledge into a shareable system that can be passed from generation to generation."

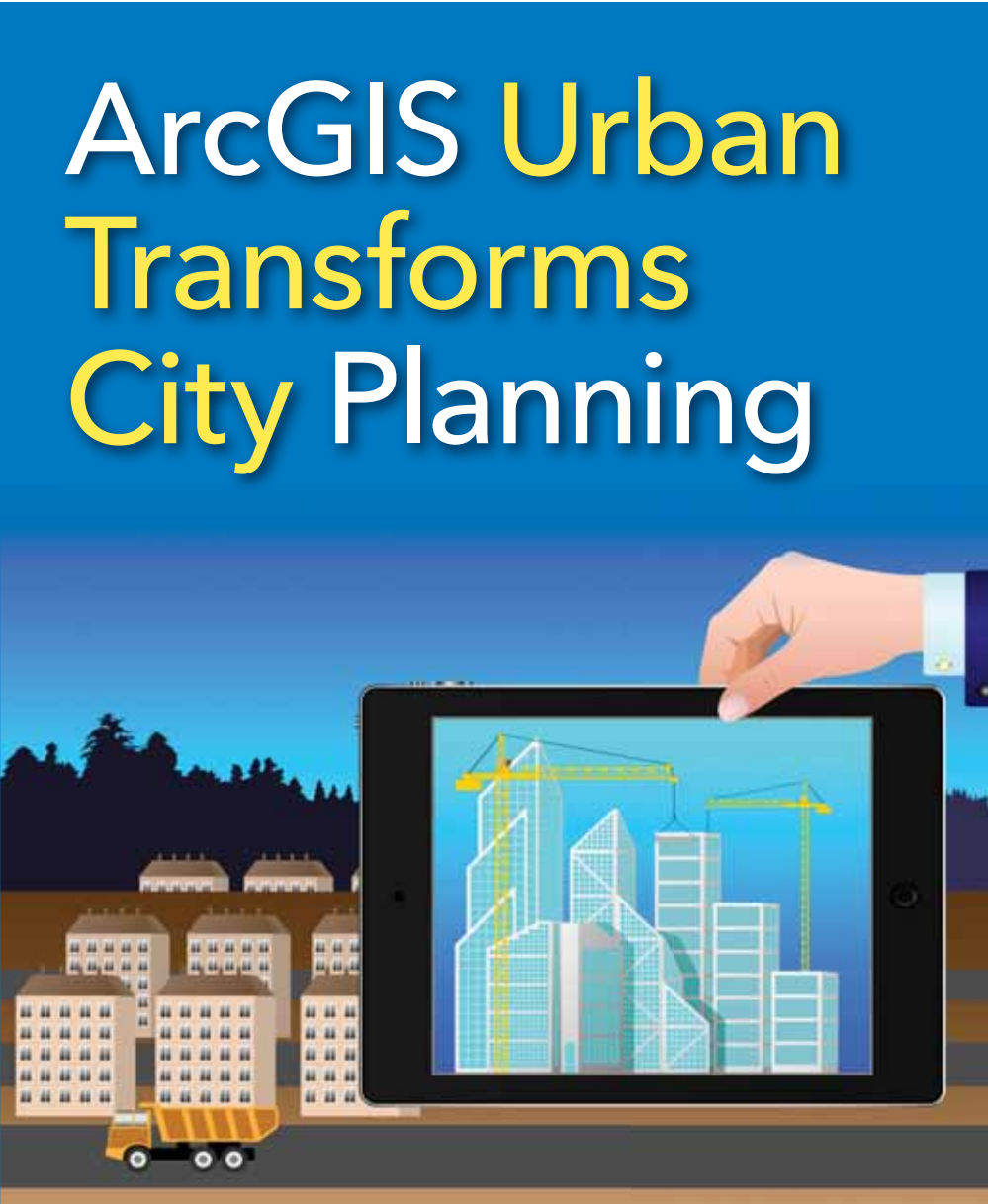## GIS AND HANDHELD APPS POWER DIGITAL TRANSFORMATION

Taylor has expanded its use of GIS through many apps that farm managers and workers access on mobile devices. It can now take real-time data on business, operations, and environment out to their 30 farms. The ability to view GIS data in the field helps the company understand the complexity of its operations.

The apps allow farm managers to redline maps and share real-time changes in conditions or record suggestions. The offline editing capability in Explorer for ArcGIS is crucial as many of the farms are in rural areas with spotty cell signal coverage. Explorer also provides a handy repository for data and attachments, such as permits that can be shown to Fish and Wildlife inspectors.

Taylor uses Survey123 for ArcGIS for field data collection, such as reports of shoreline debris or presence of herring spawn, which it needs to report to regulators. It uses Collector for ArcGIS to update operational data about farm beds. The data are used to better evaluate the status of various farms.

Workforce for ArcGIS helps the collaboration with the local Squaxin Tribe in Oakland Bay, Washington, who have been harvesting shellfish for centuries. A coordinated effort to improve the health of the watershed has been mounted by managing water quality sample assignments between field workers and the tribe.

Drone2Map for ArcGIS has helped improve the mapping of farm beds. Drones allow the capture of beds at low tide with a clear idea of elevation. The company can better see beach drainage and layout the beds so the seed won't get washed away. ∎

The ability to view GIS data in the field helps Taylor Shellfish Farms understand the complexity of its operations.

ArcGIS Urban Transforms City Planning

ArcGIS Urban is a web-based system designed to improve urban planning and decision-making. For planning commissioners and teams, local policymakers, city council members, and the public, it offers a comprehensive overview of development activities along with a suite of tools they can use to shape the urban development life cycles of their communities.

The Boston Planning & Development Authority (BPDA) facilitates more than 80 large development projects in and around Boston, Massachusetts, every year. With ArcGIS Urban, the public agency can consolidate the development pipeline into a central, shareable view of projects.

Regional and local regulations have consistently guided the growth and development of modern cities, but in the last 50 years, the connection between the rules that govern land use and the physical outcome has broken down. In many cases, this has resulted in urban sprawls that continue to grow, despite demand for mixed-use, walkable communities.

ArcGIS Urban represents an evolutionary step forward in how people interpret and better apply complex land-use regulations to make cities better by fostering a more liveable urban form. With an immersive 3D experience, Urban gives organisations the capacity to visualise proposed transformations, enabling planners, local governments, and citizens to formulate a

Offering proactive solutions to rapid urbanisation, ArcGIS Urban is an exercise in sustainability – ensuring Better Cities, Better Life.
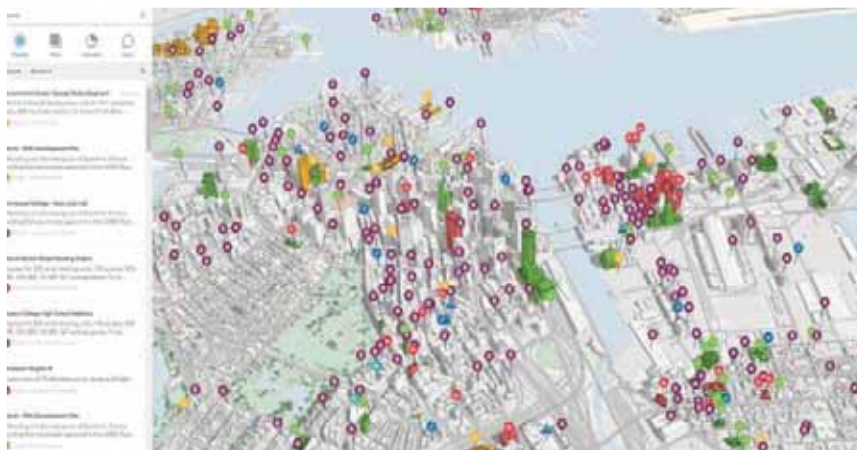
common understanding of what changes could take place in their communities.

A COMPLETE PLANNING SUPPORT SYSTEM

Urban Overview web app for standard browsers and/or mobile devices; a back-office Urban Design web app; and Esri CityEngine for desktop workstations.

Urban Overview allows users to search their cities and

ArcGIS Urban offers a comprehensive overview of development activities along with a suite of tools, which can be used by public and policy-makers alike, to shape urban development.

Urban is now integrated with CityEngine, enabling users to access plans and projects directly in CityEngine by connecting to web GIS layers in Urban.

enables users to access plans and projects directly in CityEngine by connecting to web GIS layers in Urban. Advanced downstream design workflows, such as detailed streetscape and façade modelling in CityEngine, can further leverage cross-platform interoperability with virtual reality (VR) platforms or other modelling software, including Unreal Engine or SketchUp.

With support for projects of varying sizes, Urban can strengthen collaborative planning efforts across teams and organisations. The system is designed to break through the technical barriers that often stand in the way of utilising spatial information within rigorous scenario development.

ACHIEVE COLLABORATION AND DELIVER CLARITY

Local communities need to address the challenges that are related to affordable housing, walkability, and multimodal mobility, but they cannot do that holistically without examining the local zoning and land-use codes that encourage (or discourage) certain types of development. With ArcGIS Urban, users can get up and running with scenario development quickly, increasing their technical capacity to analyse the economic, social, environmental, and spatial impacts of plans and policies. Whether a community is undergoing a downtown revitalisation or attempting to foster better transit-oriented

explore the locations of planned development as well as their status. Allowing stakeholders to visualise citywide projects in a standard web browser supports the inclusive review of new projects and streamlines the building application process, potentially reducing it from months to weeks. A shared view of the development pipeline also increases public transparency, lessens uncertainty, and promotes greater community involvement in the review process.

The Urban Design tools blend spatial information into a focused set of scenario-planning capabilities. Starting with authoritative data on existing conditions provides the basis for future scenario development and reporting on key performance indicators, such as the number of new households and jobs. Users can author specific area plans that incorporate zoning considerations into the design process, which improves productivity and the viability of proposed development patterns.

CityEngine is now integrated with ArcGIS Urban as well. This

development, Urban builds zoning considerations into the scenario-based process, ensuring the viability of conceptual plan development.

Urban also makes it possible to track progress by incorporating the active development pipeline, which comes in handy when creating plans for entire neighbourhoods, since these often take years to implement and, thus, need to remain flexible and responsive to market forces. More importantly, since both planners and developers have a clear view of development guidelines, the review period required for building applications is reduced, and projects that align with the local community's planning objectives are encouraged.

In ArcGIS Urban, users can share proposed projects, like the City of Zurich did when it presented these building candidates in a competition for a new public school in the Allmend neighbourhood.

Each project in ArcGIS Urban can have a 3D model that portrays the shape and height of the major massing components of draft building proposals as they undergo revisions. Incorporating building information modelling (BIM) and other types of 3D information through the project submission process can improve spatial accuracy and certainty when evaluating the impacts related to shadow cast and viewshed. This gives planning teams a complete understanding

Urban tracks progress by incorporating the active development pipeline, and ensures that neighbourhood plans remain flexible and responsive to market forces.

ArcGIS Urban incorporates building information modelling (BIM) that creates 3D models portraying the shape and height of building proposals, thereby improving spatial accuracy, and impact assessment.

of how proposed projects will affect the built environment and ensures consistency with land-use regulations.

In addition, users can take advantage of shareable web scenes and distributed collaboration in Urban, which can help build consensus across government, the real estate development community, and the public during the review process. This increases the opportunity to collaborate with local residents beyond the city council room, as all relevant stakeholders have a complete view of proposed projects.

SHAPING THE FUTURE OF YOUR COMMUNITY

ArcGIS Urban is a new solution designed to respond to the significant challenges that cities face—from upsurges in population to the related development pressures. Planning can be a time-consuming and expensive process that is often reactive to changes in the local real estate market or the broader economy. But by following just three steps, professionals can leverage Urban to proactively increase resilience, expand transparency,

and achieve equality in city planning.

First, users translate their local regulations—parameters such as building use, density, and dimensional requirements— into a system of record that they need for a modern zoning code. Many cities today are undergoing multi-year endeavours to rewrite their zoning codes and incorporate improved form-based urban design concepts. With Urban, users can assimilate this work into a framework to support scenario planning.

Second, users establish shared views of plans, projects, and indicators both internally across departments and with community stakeholders. A

Urban steps out of the ivory tower through shareable web scenes and distributed collaboration. It helps build consensus.

shared view of what is being built and planned is necessary to make important decisions as a community, and that can stimulate private investment and garner more support for long-term economic development goals.

Third, city officials can use Urban to reach elusive populations while also increasing transparency for residents who are unable to attend council meetings. This ameliorates the widespread urban development processes that are prevalent today, wherein developers present their projects to city councils and the council votes on them without much community involvement.

Urban makes it possible to create plans that foster the kind of human-scale communities the public wants while also promoting transparency in the development pipeline and offering new opportunities for public engagement.

With a common operating view of plans, projects, and indicators, Urban empowers users to produce an attractive, sustainable, and equitable future for prosperous cities. ∎

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