

## Geospatial Analytics for Planet Earth: Sensing and Making Sense

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### (1) A description of the discovery opportunity.

**Why Geospatial.** Geospatial observations/analytics are integral to a host of environmental solutions at many spatial and temporal scales: examples include harmful algal bloom prediction, invasive species monitoring, studying urbanization patterns and smart, connected cities, optimizing biomass production, public engagement in environmental science and understanding climate change effects on agricultural productivity and global nutrient fluxes. The key role of geospatial observations/modeling in future initiatives is present in several strategic activities:

**NSF's 10 Big Ideas<sup>1</sup>:** Growing Convergent Research at NSF (*"understanding food, energy, water nexus; exploring the universe at all scales"*), Harnessing the Data Revolution (*"real-time sensing/computation of observational data from the atmosphere, land and water"*), and Understanding the Rules of Life (*"cross different scales - spatial, temporal, levels of biological organization and complexity"*).

**National Academies of Sciences, Engineering, and Medicine survey<sup>2</sup>:** Top Science and Applications Priorities for the Decade 2017-2027 include: i) *"What are the structure, function, and biodiversity of Earth's ecosystems [and how do they] change in time and space?"*, ii) *"What processes determine the spatio-temporal structure of important air pollutants?"*, and iii) *"How is the water cycle changing?... How are these changes expressed in the space-time distribution of rainfall, snowfall, evapotranspiration, and ...frequency ...of droughts and floods?"*

**Why Geospatial @ESF.** Beyond the societal value and long-term importance of geospatial activities, ESF is uniquely positioned to invest in geospatial monitoring and analytics due to:

- Strong fit to ESF's mission: Geospatial activities offer direct linkages to two of the four "compass points" identified in the Vision 2020 Bridge document<sup>3</sup>: *Environmental and Natural Resources Information Systems* and *Applied Ecology and Conservation Biology*.
- Existing interdisciplinary critical mass: Numerous ESF units currently conduct geospatial research that would be elevated by greater coordination and cooperation. Modest investments would have substantial returns and support pursue of large, collaborative funding opportunities.
- Extensive off-campus properties: ESF properties, while a major institutional asset, are currently underused and that use is not coordinated. Data integration/acquisition under the geospatial umbrella will offer competitive long-term research and educational opportunities, from novel augmented reality laboratories using UAS/field data to expansive modeling activities. Extracted knowledge would easily scale to similar ecosystems across the Northeastern U.S. and beyond.

<sup>1</sup>:[https://www.nsf.gov/news/special\\_reports/big\\_ideas/index.jsp](https://www.nsf.gov/news/special_reports/big_ideas/index.jsp)

<sup>2</sup>:<https://www.nap.edu/download/249383>

<sup>3</sup>:<http://www.esf.edu/strategicplan/documents/FINAL.V2020.UPDATE.05012016.pdf>

- Strong industry presence: Unprecedented local opportunities exist for university-industry collaborations. NY State, via the Upstate Revitalization Initiative (URI), is currently investing \$250M in business development associated with Unmanned Aerial Systems (UAS). This investment is local thus limiting competition to Syracuse’s five neighboring counties. ESF has been forming key collaborations with large companies that already have a presence in CNY (e.g. SRC, OBG) and those interested in moving here (Airbus: confidential information). Beyond URI funding, there will be a slew of opportunities to meet industry’s professional development and research needs through novel academic offerings, by tapping into difficult-to-penetrate funding mechanisms building on industry networks (e.g. Dept. of Defense), and creating promising development programs (e.g. sponsored chairmanships/student positions).

**Activities.** To foster the robust collaborations needed for successful inquiry we propose to establish at ESF a global geospatial center (G2C). The G2C’s mission is to become an international leader in fostering environmental stewardship by **acting as the initiator and catalyst of multi-scale, inter-disciplinary research, education and outreach.** More specifically, G2C will coordinate geospatial activities and leverage synergies in order to focus on:

- Advancing societally important and financially sustainable research via geospatial data acquisition (e.g. satellite, UAS, field sensors) and interdisciplinary models (e.g. environmental / human health, food/energy security, water/air pollution control, climate adaptation).
- Offering novel, relevant, and visionary academic programs that reflect: i) market needs and future employment trends (e.g. geographic/drone analysts, “dual language” environmental/geospatial scientists), ii) education technology advancements (e.g. augmented reality), iii) evolving needs of future students (e.g. global access via online versus residential programs), iv) ESF resources (e.g. current faculty expertise, programs, off-campus properties).
- Establishing and enhancing key partnerships with industry, state and federal agencies and neighboring academic institutions (see bullet #4 below).
- Improving ESF’s outreach starting with city schools and the downtown Museum of Science & Technology by building on the success of the ESF in the High School to reach national and international audiences via effective, multi-modal, online campaigns including citizen science.

## **(2) A description of undergraduate and graduate programs.**

According to NSF’s 10 Big Ideas<sup>1</sup> a major goal is to “*train the next generation ... to approach scientific inquiry in a way that crosses scales and scientific disciplines*”. We propose to train a new generation of interdisciplinary data scientists skilled in developing novel understanding of spatial phenomena and in applying new knowledge to societal and environmental grand challenges. A new undergraduate major in “Geospatial Science and Analytics” will be proposed covering a strong market need for geospatial scientists that are proficient in large geospatial data analytics (e.g. machine learning, cloud computing), data acquisition (e.g. UAS, satellites) and geographic science (e.g. uncertainty). This major will inherit existing course offerings from ERE, ESt and FNRM and the ESc. Env. Information & Mapping option area. We also propose two online graduate certificates in “Geospatial Analytics” and “Remote sensing/UAS analysis”. There is a considerable market both locally (through the \$250M NYS URI investment), nationally (Dept. of Defense, USGS, NASA and eng. companies), and globally (upcoming markets such as India, China). The U.S. Dept. of Labor is projecting related job growth of 29% nationally through 2024<sup>4</sup>.

<sup>4</sup>: Data from Dept. of Labor Long-Term Occupational Projections Report (Dr. Spuches, personal communication)

**(3) A list of agencies, partners, and funding entities AND**

**(4) Partnerships with other academic, government, and private organizations.**

Potential funding sources within NYS include DEC (Lands and Forests, Water and Fish and Wildlife divisions), Fort Drum Army Base and the numerous existing (e.g. SRC, OBG) and new UAS/geospatial companies expected via the URI initiative. Tackling important societal questions at multiple spatial/temporal scales is typically attracting a range of foundations (Gates, Keck, Hewlett, Ford foundations) and private donors. Numerous federal agencies would support related activities, including traditional ESF funders such as NSF, NASA, EPA and USGS and undertapped agencies such as NIH and DoD. Academic partnerships would include RIT with their strong sensor program, SU with their background in aerospace/electrical eng. and SUNY Upstate (env. health).

**(5) How the initiative will increase use of ESF assets especially properties beyond Syracuse.**

ESF properties offer unique opportunities (e.g. TIBS, AEC). Long-term monitoring/modeling activities will be coordinated through existing and new satellite/UAS observations, location-based field data (e.g. trap cameras) and geospatial analytics. Our thoroughly inventoried properties could also provide a unique calibration opportunity for a range of UAS/satellite studies. Educational and outreach efforts will be enhanced through augmented reality laboratories, where students would navigate a natural environment fused with geospatial information layers.

**(6) How the initiative will inform policy, enhance reputation, and have a global impact.**

ESF's visibility would be enhanced with the addition of forward-looking science and methods that are addressing important environmental and societal questions as identified by numerous federal agencies (see question #1). Our initiative is applicable at multiple scales, from our localized forest properties to global studies with the use of satellite observations. It is important for ESF to expand on its reputation with our visionary, global, cutting edge, interdisciplinary geospatial initiative.

**(7) A description of new investments (including new faculty hires and support).**

ESF is positioned to excel in this area because logistically the necessary critical mass of faculty members is already present (18 faculty across five depts.). Our team also has a proven funding record (4 Exemplary Researchers). Key new faculty hires will have a multiplier effect through the numerous potential collaborations with existing faculty. G2C will focus on sensing (observations) and making sense (analytics). In terms of sensing, G2C will complement ESF's current strengths in satellite observations with a new faculty hire targeting **UAS development and analysis**. A primary responsibility for this hire would be the new "Remote sensing/UAS analysis" online certificate, while considerable new collaborative research opportunities will become attainable. In terms of geospatial analytics our campus would benefit from a **Geocomputation** expert who will assist with the "Geospatial Analytics" graduate certificate. Both hires would qualify for the SUNY's Empire Innovation Program under the AI/Computing/Critical Infrastructure priority areas. Establishing the new undergraduate major in "Geospatial Science and Analytics" would require 1-2 hires in related areas such as Data Science, Spatial Epidemiology, Atmospheric Remote Sensing and/or Geovisualization. These hires would contribute to multiple research initiatives across campus, could bring Physics to ESF, and concurrently support several existing programs.

## Geospatial Analytics for Planet Earth: Sensing and Making Sense

We propose to establish a Global Geospatial Center (G2C) at ESF. The G2C's mission is to become an international leader in fostering environmental stewardship by acting as the initiator and catalyst of multi-scale, inter-disciplinary research, education and outreach. Discovery funds will be used to increase current team capabilities and hire key new members. Funds will be used to: i) purchase equipment (e.g. drone software/hardware, computing servers for large geospatial data processing), ii) hire students/postdoc to assimilate and disperse geospatial data across our institution, iii) support faculty to coordinate and undertake the proposed research/education activities, iv) support travel to establish key partnerships (e.g. foundations, federal agencies).

Within the three year period we will submit large collaborative proposals to federal agencies (NASA, NSF, DoD, NIH, NOAA, USGS, USFS, EPA) and foundations (Gates, Keck, Hewlett, Ford), establish online graduate certificates in "Geospatial Analytics" and "Remote sensing/drone analysis" (pending faculty hires), seek funds from industrial partners/donors, and pursue large NYS funding opportunities (Upstate Revitalization Initiative, NYSDEC).

The program will be self-sustainable beyond the seed period through: i) tuition generation of the online certificates (enrollment of 40 students per year) and the new undergraduate major in "Geospatial Science and Analytics" (enrollment of 30 students per year) and ii) the continual availability of topical funding recognized in strategic plans of federal agencies, mission statements of foundations and the expected substantial industry presence in the area.

Geospatial observations and analytics are integral to a host of environmental solutions at many spatial and temporal scales. As new satellites are launched with improved spatial resolutions, revisit times (e.g. nanosatellites) and technologies (e.g. lidar) along with the proliferation of Unmanned Aerial Systems (UAS), earth monitoring capabilities will offer unprecedented and transformative capabilities and opportunities from local to global scales. The key role of geospatial observations/modeling in future initiatives is supported in several strategic activities such as NSF's 10 Big Ideas and the National Academies of Sciences, Engineering, and Medicine Survey. Importantly, these geospatial observations at large scales can be well integrated with large national and statewide environmental databases (e.g., USFS FIA, NSF NEON, PRISM, MESONET) to prepare transformative proposals to study the dynamics of coupled natural and human systems - an area at the core of ESF's strength.

Beyond the societal value and long-term importance of geospatial activities, the proposed G2C will transform ESF research/education capabilities with a high return on investment. We will: i) leverage the current substantial interdisciplinary expertise with only a few additional key hires, ii) make use of a substantial ESF asset, our off-campus properties, for augmented reality educational offerings and long term sensor calibration and ecosystem understanding activities, iii) use our significant competitive advantage to establish transformative university-industry collaborations as NY State, via the Upstate Revitalization Initiative (URI), is currently investing \$250M in business development associated with UAS, iv) establish novel and in high demand academic programs that fit well with ESF's mission while also taking advantage of existing programs, v) be able, where appropriate, to pursue the majority of these initiatives independently of other academic institutions, thus collecting the benefits.