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Environmental Forensics: Drones and Advanced Technologies to Track Eco-criminals

Posted by **Massimiliano Lega** of University of Naples "Parthenope" on September 26, 2016



Professor **Massimiliano Lega** has a Master's Degree and a Ph.D. in Aerospace Engineering, and is currently a professor on the Environmental Engineering themes and director of the Environmental Engineering Forensic Lab at the University of Naples Parthenope – Italy. He is also an Associate Researcher on the Italian National Research Council (CNR), President of Technical/Scientific Advisory Committee of Campania Sea/Coasts Observatory and Technical Consultant for several Italian Government departments and agencies. In this introductory post for Voices he talks about his work and reports on his recent meetings and discussions with research collaborators at U.S. institutions.

A conventional criminal investigation begins with the evidence of the crime that defines the scenario to be investigated. For environmental crimes, the investigation often begins with the evidence of the damage rather than of the illegal act of pollution. Environmental crimes have some complicating factors: often the consequences of pollution appear in a different place from, or a long time after, the pollution has been committed; and the correlation between the source and the damage depends upon the morphology of the scenario and the physical phenomena that permit the transport of the pollutants.

Standard methods of pollution-source detection, including surface water quality sampling and visual stream surveys, do not provide effective coverage of large surfaces. Moreover, it is very difficult to detect and correlate causes and effects in locations of small pollution sources or contamination over a wide area.

"To increase the effectiveness of the investigations, human senses can be 'augmented' using a range of sensory instruments and the power of information technology."

For these reasons environmental crime investigations must be effected via complementary bottom-up and top-down approaches. In order to increase the effectiveness of the investigations, human senses can be "augmented" using a range of sensory instruments and the power of information technology.

In recent years, I have introduced new methods and technology applications for detecting, evaluating and tracking signs of environmental contamination and/or illicit practices. I use a variety of advanced aerial platforms, a suite of sophisticated sensors, and new detection software that far exceed the capabilities of traditional methods of pollution detection.

In particular, I use an integrated approach that combines aerial platforms (e.g. drones), advanced sensors (e.g. IR cameras) and specific IT tools (e.g. GIS, multi-view 3D reconstructions and edge-detection) for use in environmental police investigations. This is the first known use of these methods in both the fields of environmental research and law enforcement.

The developed system, previously tested in research activities, has recently been validated by several Italian Government Agencies (Public Prosecutor's Office, Carabinieri, Coastguard, Finance Police, State Forestry Corps, and others) and is currently being used for detecting pollution and environmental crimes in official forensic activities I direct.

Forensics in Environmental Studies

The results of the current research activities provide an example of how law enforcement and university research teams can collaborate on developing enhanced environmental protection methods that highlight the importance of forensics in environmental studies.

The development of an integrated system approach is also based on a mutually beneficial cooperation among several national and international research groups and, particularly, with U.S. teams (University of California San Diego, University of Washington Seattle, College of Rhode Island, College of Charleston, State University of New YorkSyracuse, EPA, NOAA, and others).

Fulbright Collaborations

Most of collaborations with these U.S. researchers stemmed from previous **Fulbright** awards that allowed U.S. researchers to visit the University of Naples, Parthenope, where I am based.

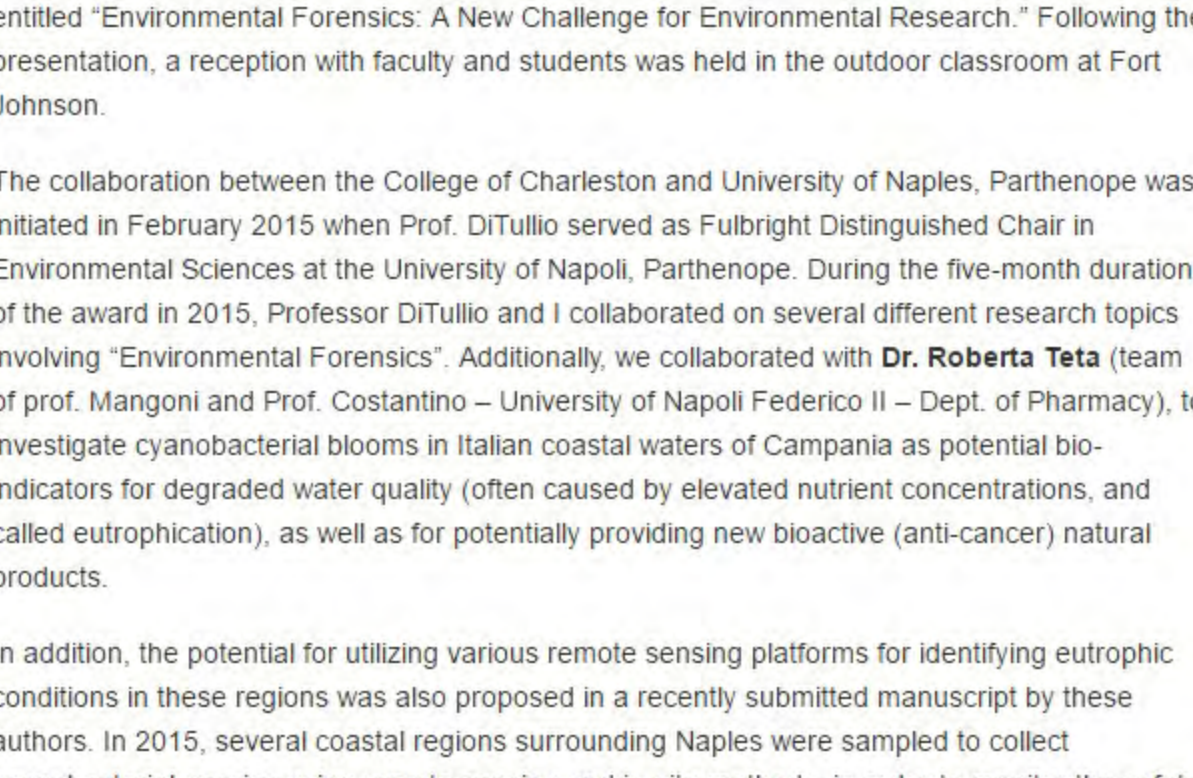
In August and September 2016, I was invited to continue this Fulbright-sponsored research collaboration by presenting several lectures/seminars with the patronage of the Fulbright Commission at different U.S. Universities, Research Centers and at the National Geographic Society in Washington D.C., on the emergent theme: "Environmental Forensics".

My mission was to continue and foster the collaborative research efforts initiated during previous Fulbright awards as well as sparking new research initiatives with U.S. scientists.

A synoptic report of each segment of the trip at the institutions visited and an abstract of the ongoing activities with their representatives is detailed below.

College of Charleston

The first segment of the trip included the visit with **Prof. Jack DiTullio** at the College of Charleston (photo below).



I presented a formal lecture as part of the Fort Johnson 2016 Fall Seminar Series. This seminar was attended by scientists and students from several academic and federal institutions at Fort Johnson, including the Hollings Marine Laboratory, College of Charleston's Grice Marine Laboratory, South Carolina Division of Natural Resources, Medical University of South Carolina, and the NOAA and NIST federal agencies. The seminar was presented on August 26 and was entitled "Environmental Forensics: A New Challenge for Environmental Research." Following the presentation, a reception with faculty and students was held in the outdoor classroom at Fort Johnson.

The collaboration between the College of Charleston and University of Naples, Parthenope was initiated in February 2015 when Prof. DiTullio served as Fulbright Distinguished Chair in Environmental Sciences at the University of Napoli, Parthenope. During the five-month duration of the award in 2015, Professor DiTullio and I collaborated on several different research topics involving "Environmental Forensics". Additionally, we collaborated with **Dr. Roberta Teta** (team of prof. Mangoni and Prof. Costantino – University of Napoli Federico II – Dept. of Pharmacy), to investigate cyanobacterial blooms in Italian coastal waters of Campania as potential bio-indicators for degraded water quality (often caused by elevated nutrient concentrations, and called eutrophication), as well as for potentially providing new bioactive (anti-cancer) natural products.

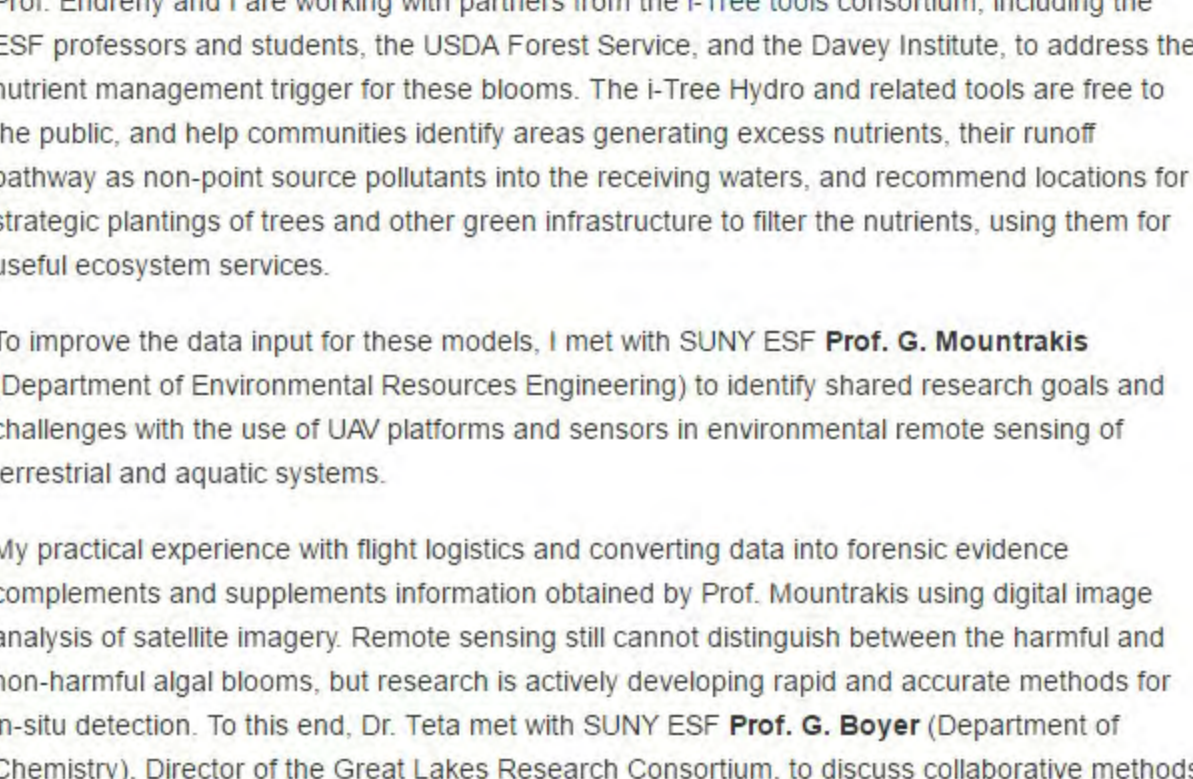
In addition, the potential for utilizing various remote sensing platforms for identifying eutrophic conditions in these regions was also proposed in a recently submitted manuscript by these authors. In 2015, several coastal regions surrounding Naples were sampled to collect cyanobacterial species using remote sensing and in-situ methods, in order to monitor the safety of the surface waters.

During the visit to Charleston, SC, isolation of pure strains of cyanobacterial species from the microbial consortium collected in 2015 was performed using high speed flow cytometric cell sorting. The pure cyanobacterial isolates will soon be tested for the presence of bioactive natural products.

In addition, during the first part of my trip to the southeastern coastal areas of the United States, new cyanobacteria samples were collected and will also be tested. These new cyanobacterial isolates from a eutrophic area close to the Lake Okechobee in Florida were collected by myself and Dr. Teta and cultures were set up at the Grice Marine Lab in Charleston for isolation of pure cyanobacterial species.

SUNY: College of Environmental Science and Forestry

The second segment of the trip was to the Great Lakes and Finger Lakes regions of New York, hosted by the State University of New York College of Environmental Science and Forestry (SUNY ESF). The idea for this visit originated in the spring of 2016 while SUNY ESF **Prof. Ted Endreny** served as a Fulbright Distinguished Chair in Environmental Sciences at University of Napoli, Parthenope. During this portion of the trip a collaborative manuscript on remotely sensed pollution detection was finalized, two seminars were delivered, field sites were visited, and new professional contacts and proposal ideas were established.



Professors Massimiliano Lega and Ted Endreny at the State University of New York College of Environmental Science and Forestry.

Nutrient management is critical to the water resources of this area, which serve as a drinking water supply as well as many other social, economic, and environmental functions. Two examples of problems include Sodus Bay, New York and Toledo, Ohio.

On Sodus Bay in Lake Ontario for two weeks in August 2010 a bloom of toxic cyanobacteria formed and wreaked havoc on residents and tourists; and on Lake Erie in August 2014 an enormous but short-duration harmful algae bloom shut down the water supply for entire city of Toledo.

Prof. Endreny and I are working with partners from the I-Tree tools consortium, including the ESF professors and students, the USDA Forest Service, and the Davey Institute, to address the nutrient management trigger for these blooms. The I-Tree Hydro and related tools are free to the public, and help communities identify areas generating excess nutrients, their runoff pathway as non-point source pollutants into the receiving waters, and recommend locations for strategic plantings of trees and other green infrastructure to filter the nutrients, using them for useful ecosystem services.

To improve the data input for these models, I met with SUNY ESF **Prof. G. Mountrakis** (Department of Environmental Resources Engineering) to identify shared research goals and challenges with the use of UAV platforms and sensors in environmental remote sensing of terrestrial and aquatic systems.

My practical experience with flight logistics and converting data into forensic evidence complements and supplements information obtained by Prof. Mountrakis using digital image analysis of satellite imagery. Remote sensing still cannot distinguish between the harmful and non-harmful algal blooms, but research is actively developing rapid and accurate methods for in-situ detection. To this end, Dr. Teta met with SUNY ESF **Prof. G. Boyer** (Department of Chemistry), Director of the Great Lakes Research Consortium, to discuss collaborative methods to improve harmful algal bloom monitoring and management. Dr. Boyer is the lead in several harmful algal bloom projects, including the Sodus Bay site.



A "special gift" to the speakers at the dinner event "Environmental Forensics with Remote Sensing Methods", at Attilio's Italian Restaurant, in Syracuse, NY.

Before leaving SUNY ESF, Dr. Teta and I each delivered a seminar on September 6, 2016 as part of a dinner event entitled, "Environmental Forensics with Remote Sensing Methods", at Attilio's Italian Restaurant, in Syracuse, NY. The seminars were sponsored by the Council on Hydrologic System Science () and the SUNY ESF Outreach Office community professional development hour (PDH) lecture series. The audience consisted of undergraduate and graduate students and faculty from SUNY College of Environmental Science and Forestry and Syracuse University, as well as practicing scientists and engineers from many firms and agencies the community interested in more effective water quality monitoring programs.

University of Rhode Island

The third segment of the trip was to the University of Rhode Island in Kingston, RI. There, I met with **Professor Paul Bishop**, Associate Dean for Research of the College of Engineering (with me in the photo below). Professor Bishop served as Fulbright Distinguished Chair in Environmental Sciences at the University of Naples Parthenope in the spring of 2013. While there, he and I conducted research on the use of drones for environmental forensics, research which has led to the publication of one refereed paper and three conference proceedings articles. Others are in preparation.



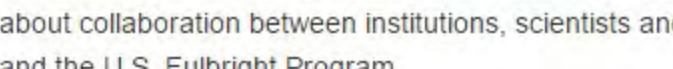
At the College of Rhode Island, I presented a formal lecture entitled "Environmental Forensics: A New Challenge for the Environmental Research" to a large group of graduate students, undergraduate students, faculty and researchers from environmental engineering, ocean engineering, oceanography and geosciences. This presentation was very well received. In addition, the lecture was video-taped for presentation to a multi-university initiative sponsored by Engineers for a Sustainable World (ESW) called "Wicked Problems in Sustainability Initiative (WPSI)". This is a multi-institution collaboration between ESW, the University of Rhode Island, the University of Pittsburgh, Rose-Hulman Institute of Technology and Rochester Institute of Technology. More than 120 students will view this presentation as part of their Fall 2016 curriculum, as well as others who view it on the ESW website.

In addition to the presentation and a discussion about my research, our group saw a demonstration of National Geographic's remote imaging cameras and devices in the Society's engineering workshop, where National Geographic develops and adapts technology such as drones to help with photography and other imaging in remote places, such as deep under the sea. The tour and lecture was given by **Eric Berkenpas**, Director of Engineering, Remote Imaging.

The delegation then had a brief introduction and conversation with **Dr. Enric Sala**, a marine ecologist with more than 120 scientific publications who is a National Geographic Explorer in Residence and the creator and head of the Society's Pristine Seas project.

At a working lunch hosted by the Italian Embassy, there was a continuation of the discussion about collaboration between institutions, scientists and storytellers such as National Geographic and the U.S. Fulbright Program.

Keywords: Fulbright Italy Massimiliano Lega University of Naples Parthenope



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Voices director: David Braun (dbraun@ngs.org)

Fighting Wildlife Crime: The Unsung Heroes



Journalist and National Geographic Fellow Bryan Christy uses investigative journalism to expose illegal wildlife trafficking around the globe. In this video he introduces a series of interviews with the people fighting wildlife crime on the front lines.

Watch all the videos in the series >>

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Follow the links on the sidebar of any of the blog's pages for details and tips on how to apply for a Fellowship.

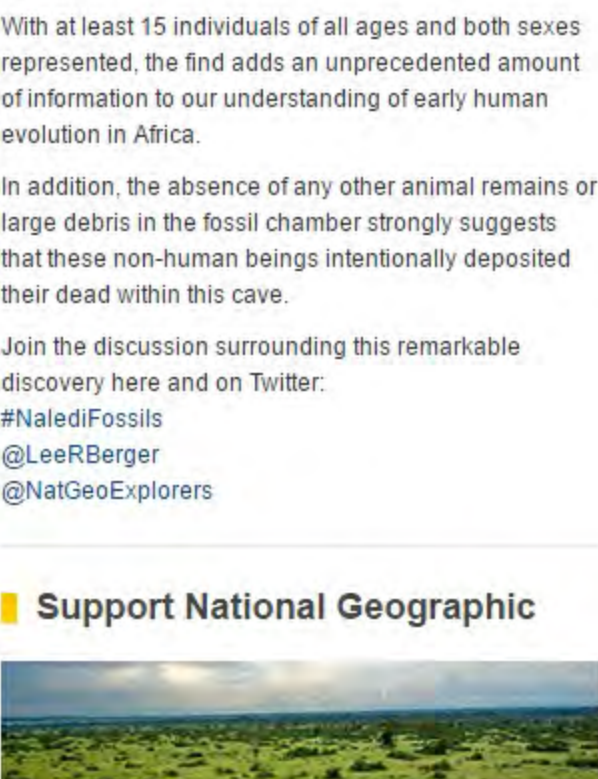
Photo of the 2016/2017 class of Fellows by Randall Scott.

Featured Research: Mushara Elephant Project



Caitlin O'Connell and her husband, Tim Rodwell, started the Mushara Elephant Project in Namibia 24 years ago to better understand elephant social structure, communication and health in order to apply this knowledge to improved care in captivity and ultimately to elephant conservation in the wild. O'Connell is on the faculty at Stanford University School of Medicine and CEO of the elephant-focused nonprofit, Utopia Scientific. A grantee of the National Geographic Society, she is also an award-winning author of six books about elephants. [Read Caitlin's dispatches from Mushara.](#)

Nat Geo Expedition: Rising Star



Two years after being discovered deep in a South African cave, the 1,500 fossils excavated during the Rising Star Expedition have been identified as belonging to a previously unknown early human relative that National Geographic Explorer-in-Residence Lee Berger and team have named *Homo naledi*.

With at least 15 individuals of all ages and both sexes represented, the find adds an unprecedented amount of information to our understanding of early human evolution in Africa.

In addition, the absence of any other animal remains or large debris in the fossil chamber strongly suggests that these non-human beings intentionally deposited their dead within this cave.

Join the discussion surrounding this remarkable discovery here and on Twitter: [#NalediFossils](#) [@LeeRBerger](#) [@NatGeoExplorers](#)

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