Cities are the New Galapagos: using IoT and ubiquitous computing to sense urban flows and raise ecological awareness

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ABSTRACT
This position paper argues that in the age of Anthropocene if cities are the “New Galapagos” then we should rethink how we design for this new ecological context. Building on recent findings from biology and ecology, that show raising biodiversity in urban environments, we form a discussion of the role of urban informatics in promoting more sustainable cities. In particular looking at the opportunities of rich urban environments and raising awareness of humans about these sometimes-hidden phenomena of non-human contexts. We propose that instead of trying to push for new technology centric applications of sensors and networking platforms we should invest more in trying to find ecological uses of these technological possibilities.

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Smart cities; participatory design; biodiversity; sustainable interaction design.

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H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
The title of this position paper draws from Matt Ridley’s article and builds on the optimistic vision of scientific rationality and liberal humanism shared by others like Steven Pinker [1]. It provokes the contradictory premise of the workshop that we can design or co-create post anthropocentric urban environments avoiding eocidal (smart) cities. By 2030 60% of the world population will be living in cities (an increase of 20% from 2012) and 10% of the landmass of the planet will be urbanized. According to human impact studies, 75% of the planet land surface is experiencing measurable human pressures [2]. The current global diversity loss is estimated to be 100 to 1000 times higher than the naturally occurring background extinction rate [3]. However, entirely new ecosystems are emerging and adapting to these new habitats. Despite the global decline, there is scientific evidence of the rising number of species in cities when they are declining in the countryside [4]. In the age of Anthropocene if cities are the “New Galapagos” then we should rethink how we design for this new ecological context. How can we design cities to leverage the raising biodiversity and as consequence contribute to more sustainable cities?

Humans are global ecosystem engineers creating, modifying and destroying habitats. Unlike ants and beavers who create more habitat heterogeneity providing localized support for species not found elsewhere, humans play a central ecological role at a global scale. In the words of Dutch biologist, Menno Schilthuizen [5] we cannot continue to factor out humans when we talk about ecology, evolution, and nature. Either we myopically focus our attention on the diminishing fraction of the habitats where human influence is still negligible, or we quarantine nature from the harmful impacts of humans. Both are not sustainable courses of action given that humans are the single most influential ecological force in the planet.

In the age of Anthropocene cities are indeed becoming the “New Galapagos”. They provide a richer habitat for species to adapt and evolve, from pigeons, to crows, brush-turkeys, lizards, foxes and many varieties of plants and insects. The scientifically documented examples are impressive, from carrion crows that learned to use passing traffic lights to crack nuts, blackbirds that sing at a higher pitch to be heard over the din of traffic, lizards evolving feet that better grip concrete, wildflowers that normally grow on saline seashores and now live along the winter salted roadsides or the culex molestus also known as the London Underground mosquito. These are examples of nature evolving and adapting to urban environments the ultimate anthropogenic habitat.
Design for more-than-human futures is already happening in cities. It's just not the consequence of explicit participatory design efforts but rather the outcome of plain old natural selection. As human designers and technologists we should question our role with respect to non-humans first and foremost recognizing how these agents evolve and adapt to the consequences of human intervention. We should also understand better the metrics of sustainability in this complex arena. The work of Schilthuizen and others is uncovering unexpected patterns that challenge our sometimes-arrogant human-centric conception of sustainability and sustainable development. By focusing their attention on our city parks and garden backyards biologists and ecologists are uncovering a completely new reality which challenges our misconceptions about our real power to control nature and the more than human futures.

Urban informatics provides unique opportunities to understand the impact of ubiquitous computing and data science in designing and understanding the urban experience. Until recently most efforts in urban informatics employed a technocratic approach, addressing environmental sustainability through more efficient and sustainable processes. Human-centered and participatory design emerged as a natural counterpart to this approach, enabling the integration of personal, social and cultural aspects in urban habitats through increasing citizen agency. However, both approaches are inherently human-centric and fail to address more than human perspectives. In the following we provide several examples of our own work related to sustainability and biodiversity.

In the past years at M-ITI we have worked with IoT sensors and web platforms to sense and make sense of usually hidden urban phenomena. In the BeanStalk project we used passive wi-fi routers to detect touristic flows (see VitFlow - http://vitflow.m-iti.org) and provide communities with novel visualizations about the impact of Tourism in Islands. BeanStalk and VitFlow [7] (see Figure 1) are two examples of novel infrastructures that provide large-scale sensing of the movement of people, weather conditions, social networking activity and transportation means. They were used to deploy interactive and location-based storytelling and transmedia components which engage the locals and visitors in novel services that explore the connection between the hybrid physical and digital space. Fragments of Laura [8] (see Figure 2 left) is an interactive location aware multimedia fictional story which takes visitors into a storyworld of Laura, an XVIII century protofarmacists. Ha-Vita [9] (see Figure 2 right) is web-based interactive multilinear repository of video interviews covering many aspects of Madeiran nature and culture. These two interactive media services explore the interaction between residents and visitors by giving voice to locals to talk about the richness of Madeira Island’s natural capital and local culture. It is a repository of anecdotes shared by local people as well as of educational information and scientific knowledge explained by biologists, engineers, and historians.
beEco [10] is an interactive game aiming to increasing environmental awareness among local fisherman and farmers. In this project (see Figure 3) we used a participatory design strategy to design an interactive game aiming at promoting a new and more positive dialogue between the local population and the Nature Reserve Park. Recognizing the power of relationships and the creative potential and emotional impact of children, the development team ended up involving local schools in the visual design of the game.

POSEIDON [11] is a low-cost passive acoustic monitoring system for nautical citizen science and real-time acoustic augmentation of whale-watching experiences. POSEIDON (see Figure 4 right) uses machine learning techniques to identify vocal acoustic samples of common cetaceans like whales and dolphins. The features extracted from the machine learning models are used to enhance the whale watching experience and provide citizen science data to marine biologists and environmental protection agencies. Finally, LOCOMOBIS, is a LOw-C0st MOsquito BIoacoustic Sensor where the wingbeat sounds produced by mosquitoes in flapping-wing flight are used to identify different species automatically. The sensor (see Figure 4 left) was deployed and tested in a real field deployment and our results demonstrate the practical feasibility of this low-cost non-intrusive approach for monitoring mosquitoes in places requiring vector monitoring aimed at mosquito control or eradication. Moreover, to make the system more ubiquitous and easy to interact with, we implemented a web-based application where it is possible to check the collected data, the automatic species and gender classification.

The examples reported previously emerge from our experience working as designers and technologists in one of the outermost regions of Europe known for its biodiversity and natural capital but also a world-known touristic destination. With more than 270 thousand inhabitants, Madeira Islands host the third largest metropolitan area of Portugal, welcoming more than 1,6 million tourists per year. As an Island it provides, both a unique testbed for new technological interventions that integrate non-humans, but also an important example for sustainable development where human impacts (tourism and urban) are closely co-located with a unique fragile ecosystem including many endemic species. In fact, the outermost regions of Europe (Azores, Madeira, Canary Islands and the French overseas territories account for 80% of the biodiversity in Europe.
DISCUSSION AND CONCLUSION

The premise of this workshop is that we can avoid ecocidal cities by developing new participatory techniques to co-design sustainable urban environments integrating non-human perspectives. Drawing on recent findings on the raising biodiversity of cities we argue that this process is already ongoing. Not as a consequence of participatory design, simply as a consequence of adaptation and evolution of existing organisms to the rich diversity of urban environments. The point remains that humans and non-humans are indeed interrelated and interdependent. We need new opportunities to use technology to raise awareness about this phenomenon and hence contribute to leverage the co-creation of environmentally and socially just post-anthropocentric cities. Here we have provided several examples from our previous research that uses IoT and web platforms to explore this new design space. Our premise is that instead of trying to push for new technology centric applications of sensors and networking platforms we should invest more in trying to find ecological uses of these technological possibilities.

Our future plans include deploying acoustic sensors to monitor biodiversity and design new approaches to engage citizens with these new phenomena. For instance, when using bio-acoustic sensors to detect and classify different animal species we can open new opportunities to engage and motivate citizens. Our research and related work shows that people are not aware of the rich biodiversity in urban environments. For instance, bats are a known species that coexists in cities and parks. Combined with gamification approaches we are testing new ways to engage citizens and raise their awareness about these species. The same applies to cetaceans, while deploying POSEIDON we understood that marine biologists were worried about the stress that nautical activities are causing to these animals. Instead of simply enhancing and increasing the accuracy of whale and dolphin watching activities we can use sensors and mobile applications to raise awareness about the importance of preserving the habitats of the animals. These are just two examples of how IoT sensors, web platforms and citizen science strategies can be used with a different design approach: first to raise awareness about the presence of hidden biodiversity and second to use that information to motivate people to understand better how their actions can potentially harm the underlying ecosystem. We believe this is a more positive approach with potentially more persistent results in terms of behavior change from the population.

A second line of work involves combining sensing and participatory platforms with storytelling. While storytelling is not the only way to engage people with their surrounding environment it’s certainly a critical part of the recipe. From La Fontaine tales to National Geographic documentaries our history is full of examples of the power of storytelling in engaging people with nature and sustainability. We argue that new participatory platforms should combine ubiquitous sensing with co-creation and storytelling from local citizens. Together they form a strong combination of traditional and modern techniques to raise the communication power and spur new forms of social interaction that go beyond social media.

Finally, a third line of work is looking at opportunistic sensing, using animals as sensors. This approach would solve many of the technical challenges with sensing in the large, for instance large urban areas or nature preservation areas in the borders of cities. For instance, birds and sea mammals can be used for large scale pollution and even oceanographic monitoring of large scale phenomena. The combination of both could lead to a new internet of ecological things which is probably a much better use of our infrastructure and computing arsenal as many failing IoT scenarios. The opportunities are endless but they require a new mindset that we hope could start in this workshop.
Nuno Nunes is a Full professor at Tecnico U. Lisbon and the President of Madeira-ITI a research unit of the LARSYS Associated Laboratory. He's also adjunct faculty at the HCII at Carnegie Mellon University. Nuno’s research interests lie in the application of models to software, system and service design for the domains of environmental sustainability and participatory culture. He edited 13 books and published 130 papers in international journals and conferences in the areas of software engineering, HCI and service science. He was PI and co-PI of several research projects totaling more than 12M€ from European to nationally and industry funded. Nuno’s research in sustainability follows the overarching research goal of contributing to the development of sustainable behaviours, practices and products/services, which is particularly salient given the isolated, untouched nature of Madeira. With colleagues at M-ITI I am actively involved in the development of resource monitoring solutions, the design of novel sustainable services and the use of eco-feedback technology to reduce and motivate sustainable behaviour both individually and (via group studies and social network services) in families and communities. More recently the focus shifted to the use of acoustic sensors to detect and monitor biodiversity from mosquitoes to bats and cetaceans. Nuno is particularly interested in how this new infrastructure could be used to raise awareness about biodiversity and leverage new ecosystem services.

Valentina Nisi is currently Assistant Professor at the University of Madeira, Portugal, where she teaches and researches in the areas of Digital Interactive Design, Art and Media. She holds a degree (First class honours) in Fine Arts from the Fine Arts Albertine Academy of Turin, Italy, an MSc (First class honours) in Multimedia Systems and a PhD from Trinity College Dublin, Ireland. She worked for 4 years at MediaLabEurope MIT’s European research Partner, investigating the potential of wireless mobile technologies in cinematic non-linear narratives. Valentina has published and exhibited and thought internationally, in the domains of digital media, art and design. Her research interests focus on designing and producing digitally mediated experiences in controlled spaces as well as in the wild, merging architecture, environment and landscape with multimedia and narrative and artistic elements. Her most recent efforts are now investigating how to integrate sustainability concerns with digital art and interactive media, through designing and producing aesthetically rich interactive experiences, fostering attention and awareness towards themes such as forest fires and climate change, preservation of nature and endangered natural landscapes and ecosystems.

REFERENCES