

Institution: University of Dundee		
Unit of Assessment: UoA 32 Art and Design: History, Practice & Theory		
Title of case study: Co-Creation for Environmental Monitoring		
Period when the underpinning research was undertaken: 2015 - 2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s): Mel Woods Drew Hemment	Role(s) (e.g. job title): Professor Reader, Dundee Fellow	Period(s) employed by submitting HEI: Since: 1995 From: 2012 - 2018
Period when the claimed impact occurred: 2015 - 2020		
Is this case study continued from a case study submitted in 2014? N		

1. Summary of the impact

Research into new co-creation approaches to address environmental issues in urban and rural settings has mobilised international communities. The work has achieved impact through:

1. The empowerment and education of over 25K participants worldwide in action-orientated citizen science and data collection, and engagement of 7.8M citizens.
2. Positive environmental impact on air and noise pollution; urban infrastructure and municipal services; sustainable food growing; management of soil health and water resource.
3. Contribution to validation of Sentinel-1 satellite products for monitoring extreme climate events, such as flood, wildfire, drought and food sustainability.
4. Change in policy to the constitutional rights of Kosovan citizens, innovation by SMEs and impact on UN Sustainable Development Goals (SDGs).

2. Underpinning research

Two large scale research projects funded by The European Commission H2020, and led by Woods, addressed high priority environmental challenges in Europe. A rigorous co-creation process established the value of a novel environmental monitoring framework. Bespoke methods, tools and resources were developed and validated with stakeholders including citizens, scientists, NGOs, the open-source community, and industry and policy-makers in more than 200 individual events and workshops between November 2015 and November 2020.

Making Sense (MS) addressed issues of chronic pollution using open design for hardware, software, data and methods through the delivery of citizen science campaigns in Amsterdam, Barcelona and Pristina from 2015 – 2018. **MS** emphasised co-creation as a methodology through an eight-step process to support change-practices **[R1]**. The research revealed how communities with access and ownership of their environmental data could monitor change, analyse data, find relevance and achieve impact over time. A novel design tool, Community Level Indicators (CLIs), was created to address a gap enabling communities to generate and communicate findings, as well as formulate, track and evaluate the emergence of change longitudinally **[R2]**. '*Citizen Sensing: A Toolkit*' brought together the full scope of research from model and co-creation methods, selected case studies, metrics, insights and testimonials from participants **[R3]**.

Whilst **MS** focused on international urban cities, spanning 3 separate countries, **The GROW Observatory (GROW)** subsequently extended this reach to engage 24 rural communities in 13 EU member states over a 3-year period (2016 – 2019). **GROW** focused on a single issue, continuous monitoring of soil moisture, for sustainable food growing and climate change with people managing the land and soil. The deployment of 15,000 low cost Internet of Things sensors achieved scale and created a high quality in-situ dataset to meet the objectives of space science and earth observation **[R4]** and impact for society. GROW created decision-support information for citizens and scientists, which alongside citizens' uptake of open datasets resulted in changes in practice e.g. land and soil management, and water savings. The participant evaluation highlighted inclusion, empowerment and reward; education and peer-to-peer learning through MOOC's (17k+ active learners); the alignment of local environmental 'matters of concern' to global issues; and community resilience as vital to our framework. The research demonstrated an evidence-based strategy for storytelling to engage 7M people across the GROW website, @growobservatory social media channels, film, television, radio and webinar broadcasts. The action-orientated participatory methods and service design tools supported change and advocacy with policymakers, and found that contrary to the literature, models of participation are not static **[R5]**.

The research evidenced, for the first time, that remotely sensed soil moisture e.g. satellite-derived products, can be validated using crowdsourced in-situ soil moisture measurements to improve the accuracy of predictions for extreme climate events **[R6]**. The research has advanced the implementation of UN SDGs and targets through awareness, training, participatory methods and multi-stakeholder connections; citizen-generated datasets have provided sustained data collection to contribute to indicator level monitoring **[R7]**.

3. References to the research

[R1] Coulson, S., Woods, M., Scott, M., Hemment, D. (2018) 'Making Sense: Empowering participatory sensing with transformation design', *Design Journal*, 21(6) pp. 813-833 DOI: [10.1080/14606925.2018.1518111](https://doi.org/10.1080/14606925.2018.1518111)

[R2] Coulson, S., Woods, M., Scott, M., Hemment, D., Balestrini, M. (2018). 'Stop the Noise! Enhancing Meaningfulness in Participatory Sensing with Community Level Indicators' in *DIS '18: Proceedings of the 2018 Designing Interactive Systems Conference* New York: Association for Computing Machinery pp. 1183-1192 DOI: [10.1145/3196709.3196762](https://doi.org/10.1145/3196709.3196762)

[R3] Woods, M., Balestrini, M., Bejtullahu, S., Bocconi, S., Boerwinkel, G., Boonstra, M., Boschman, D-S., Camprodon, G., Coulson, S., Diez, T., Fazey, I., Hemment, D., van den Horn, C., Ilazi, T., Jansen-Dings, I., Kresin, F., McQuillan, D., Nascimento, S., Pareschi, E., Polvora, A., Salaj, R., Scott, M., Seiz, G. (2018) *Citizen Sensing: A Toolkit*. Making Sense. DOI: [10.20933/100001112](https://doi.org/10.20933/100001112)

[R4] Kovács, K. Z., Hemment, D., Woods, M., van der Velden, N.K., Xaver, A., Gi Esen, R.H., Burton, V.J., Garrett, N.L., Zappa, L., Long, D., Dobos, E., Skalsky, R. (2019) 'Citizen observatory based soil moisture monitoring – The GROW example', *Hungarian Geographical Bulletin*, 68 (2) pp. 119-139 DOI: [10.15201/hungeobull.68.2.2](https://doi.org/10.15201/hungeobull.68.2.2)

[R5] Woods, M., Ajates, R., Gulari, N., Burton, V. J., van der Velden, N. K., & Hemment, D. (2019). *GROW Observatory: Mission Outcomes*. EC Technical Report. Dundee: University of Dundee. DOI: [10.20933/100001130](https://doi.org/10.20933/100001130)

[R6] Zappa, L., Woods, M., Hemment, D., Xaver, A., Dorigo, W. (2020) 'Evaluation of remotely sensed soil moisture products using crowdsourced measurements', *Eighth International Conference on Remote Sensing and Geoinformation of the Environment, RSCy2020*, 16 March 2020 – 18 March 2020 pp. 88-102. DOI: [10.1117/12.2571913](https://doi.org/10.1117/12.2571913)

[R7] Ajates, R., Hager, G., Georgiadis, P., Coulson, S., **Woods, M. Hemment, D.** (2020) 'Local Action with Global Impact: The Case of the GROW Observatory and the Sustainable Development Goals ', *Sustainability*, 12(24) 10518 DOI: [10.3390/su122410518](https://doi.org/10.3390/su122410518)

4. Details of the impact

The research has led to a diverse range of changes in practice; changes in understanding of data; increased and widened participation in both research, scientific practice and innovation; in willingness and confidence to engage; and in informing and changing policy at local and national levels.

Community and social empowerment driving environmental change

People were engaged in **MS** action-orientated citizen science campaigns to gather environmental data, e.g. air quality, noise pollution and gamma radiation, to tackle failures in the reduction of urban pollution targets by municipalities. As a result, in Pristina, Kosovo, air quality data mobilised citizens to protest for the first time. **MS** framed this narrative, presenting accessible scientific research, and consequently captured headlines of major media outlet 'Prishtina Insight'. In response the government enacted emergency measures, banning city centre transport over the course of 2 days for the first time [E3]. Meanwhile, in Plaça Del Sol, Barcelona, 40 active residents took up our resources and collected data which demonstrated that WHO noise limits were exceeded on a recurrent basis, deeply affecting their lives [E4]. The noise pollution was complex, related to late night public gatherings and drinking, and exacerbated by architecture, urban planning, local policy, social behaviour, urban health, and economics. Armed with their **MS** data, citizens combined lobbying of policy makers in the municipality with an awareness campaign highlighting the noise pollution, resulting in changes to public services such as night cleaning in the square and the refurbishment of municipal spaces to deter revellers; evidence from citizens is highlighted in a documentary [E5].

Changes in policy as direct result of citizen data

Citizens often cite policy as an area in which they feel they have little agency, however our activity created opportunities to address this. The cumulative results of citizen sensing campaigns, including evidence and data given by **MS NGO** to an EU convention, resulted in change to the Constitution in Kosovo. In 2018 the Kosovo Assembly convened and passed the motion to amend citizens' right to clean air through 17 recommendations [E6]. 'Citizen Science Revolution' documentary (2018) reveals this impact, featuring citizens and investigator statements. The documentary had 37,000 views as a live broadcast and 2,150 views between 7 December 2018 and 31 December 2020 on YouTube [E5]. Policy experts have recognized the importance of citizen science and engagement in **GROW** [E7]; in 2019 Woods was invited by the European Commission Directorate General Environment to provide expertise on new 'Guidelines on Citizen Science for Environmental Monitoring', to promote citizen science for environmental policy development and implementation [E8].

Changes in understanding and practice with respect to soil management.

An independent EC assessment to validate project impact and best practice was undertaken as a part of the Knowledge Valorisation Policy; subsequently, GROW was highlighted in 'Making Research Results Work for Society – Engaging Citizens to Accelerate Use of Research Results to Benefit All' [E11]. Interviews with participants were conducted, and confirmed impacts included: In *El Hierro*, Canary Islands, farmers reduced water irrigation of crops by between '30 - 50%'; **GROW** Greece integrated soil moisture with GIS data to monitor flooding and migratory birds in a wetland (Evros Delta); Walt, a **GROW** participant in Portugal, built his own data dashboard to monitor the threat of desertification and wildfires.

GROW Soil Moisture Datasets have been accepted in the International Soil Moisture Network, a repository with 3,200 registered users to date, and released as open data with licence for innovation. The dataset is used for satellite validation, model development and validation, meteorological applications, drought monitoring and other applications (e.g.

quality control). GROW's impact regarding the validation of satellite products, making accurate modelling of extreme climate events possible, was recognised at the European Commission Group Earth Observations (GEO), a partnership of 132 governments and organisations, promoting Earth observations for a sustainable planet. The Principal at GEO, stated:

GROW Observatory ... is the first operational, continental-scale Citizens' Observatory ... for the first time, crowdsourced data has been used to validate 4 satellite soil moisture products, and 10+ different satellite products can use this dataset...GROW brings GEO into the mainstream ... It supports GEO priorities towards the Sustainable Development Goals, and addresses SDG2, SDG13 and SDG15. [E10]

Shaping Tools and data for environmental monitoring activities across the EU

Our online education programmes on the Futurelearn platform (MOOCS) have delivered 27 weeks of education, providing rigorous training to more than 25,000 people from 182 countries around the world, to ensure data quality, and impart our framework and methods for the replication of Citizen Observatories. Between 1 January 2018 and 31 December 2020), our book *Citizen Sensing: A Toolkit* has distributed 3,000 hardcopies, and is a licensed CC-BY-SA pdf resource; download data is modestly estimated at 2,400+ (UoD Discovery, 8+ additional websites) setting the benchmark to meet local and global environmental goals. Between October 2020 and 31 December 2020, **GROW** has licensed tools and data for reuse (downloaded 700+ times) [E1]. A range of NGOs, Governments, Institutes and Academia have adopted the approach including: Amsterdam Institute of Metropolitan Solutions, Lung Foundation, National Institute for Public Health and the Environment, Royal Dutch Meteorological Institute, Knowle West Media Centre, 300.000Km/s, National Institute of Public Health of Kosovo, U.S. Embassy in Kosovo and The Observatory for Public Sector Innovation [E5].

Impact has also been recognised by independent juries through the following awards to the Grow Observatory: Honorary mention **ST+ARTS prize**, ARS Electronica (2018) [E2]; **Soil and Land Management Award** (2018-19), European Landowners' Organization; **PIEoneer Awards Digital Innovation of the Year – Learning** (2020) [E9].

5. Sources to corroborate the impact

[E1] **Screen capture** evidencing download figures for 1. *Citizen Sensing: A Toolkit*, 2. *Licensed Tools*

[E2] **Award** ARS Electronica ST+ARTS prize '*Citizen Sensing: A Toolkit*'. The prize and other winners <https://starts-prize.aec.at/en/winners2018>

[E3] **National and international press** Pristina protests leading to the car ban widely reported in Kosovo in: <https://prishtinainsight.com/streets-empty-prishtina-bans-cars-mag/> ; <https://eu.usatoday.com/story/news/world/2018/03/28/kosovo-air-pollution-health-problems/459594002/> ; <https://uk.reuters.com/article/us-kosovo-pollution-protests/kosovos-pollution-draws-protesters-as-city-bans-cars-from-town-center-idUKKBN1FK1ZW>

[E4] **BBC article and video** 'Tomorrow's Cities: How Barcelona Shushed Noise-Makers with Sensors' <https://www.bbc.co.uk/news/technology-41015486>

[E5] **A documentary film** '*Citizen Science Revolution*', commissioned by Playground Magazine. A citizen's perspective through participant testimonials supporting tools in use by citizens and all nine campaigns and the impact through citizen action [Timecode featuring Woods from 50:17]. Available on multiple channels: Institute of Advanced Architecture of Catalonia, YouTube (2165 views on 11 December 2020),

<https://www.youtube.com/watch?v=hvn5LyACUYw> and Facebook broadcast (37K views on 11 Dec 2020), <https://www.facebook.com/PlayGroundMag/videos/2061510993888766>

[E6] Document Kosovo Constitution amendments with <https://europehouse-kosovo.com/monthly-event/euicc-discusses-the-air-pollution-in-kosovo-and-eu-policies-and-standards-on-air-quality/> and 'Pristina Insights' on the assembly ruling <https://prishtinainsight.com/kosovo-assembly-approves-resolution-air-pollution-prolonged-debate/>

[E7] Video Statements Petros Kokkalis MEP <https://www.youtube.com/watch?v=15DjnlwJw8A> and Hugo De Groof EC Directorate General Environment <https://www.youtube.com/watch?v=5Cj0Dt6n57c>

[E8] Letter Invitation from EC Directorate General Environment to Prof Woods

[E9] Awards European Landowners <https://www.europeanlandowners.org/awards/soil-land-award>, PIEoneer Award Certificate <https://pieoneerawards.com/2020/en/page/pieoneer-awards-2020-winners>

[E10] Document EC Statement to Ministerial Summit, GEO-XVI Plenary by Patrick Child European Commission, GEO Principal and GEO Co-Chair Deputy Director-General of the Directorate-General for Research and Innovation, European Commission

[E11] Factsheet EC Valorisation Policy verified impacts stated in deliverable reports and case studies (cited in report **[R5]**) through independent interviews with participants <https://op.europa.eu/s/ovG1>