Greening the shelter response and human upskilling through earth observation data

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Abstract

Our proposition is to support the shelter response using digital and green technologies, that will systematically equip, assess, simulate, and optimise humanitarian constructions decision making, by upskilling and empowering targeted populations towards green transition. One green and digital technology that can be used, and in substance important source of information, is earth observation (EO) data. In this communication, we present an original inductive research based on exploratory data analysis from Earth Observation. From exploratory field evidence produced thanks to EO (part 1), we will develop benefits and challenges (part 2), and as well perspectives to address the challenge of improving the human responses to climate change in Africa and optimising humanitarian constructions decision making, by upskilling and empowering targeted populations towards green transition. EO can indeed enhance relevant of decision making in humanitarian habitat, but it can also be used as educational tool (Sarti et al., 2010) to enhance human values regarding environment (Bouman et al, 2018), long as human upskilling and technology adoption challenges are addressed.

Key words

Human upskilling, humanitarian habitat, environmental impact, earth observation, remote sensing, land cover change monitoring

Introduction

The research deals with the human responses to climate change in third countries, with a focus on improvement tracks for humanitarian habitat. Several tools, guidelines, etc. have recently been developed to structure and equip a greener approach of humanitarian habitat, such as NEAT+[1], QSAND[2], SMAC tool[3] etc., however a more specific approach is needed to measure the overall environmental impact of shelter designs and turn it over in a positive value for environment. Especially, some research underlines the integration of human factors for a broader impact (Oliveira et Campos, 2019; Kuys, Jung-Ok et al., 2022).

Indeed, across Africa multiple studies show that public perception of the impacts of climate change is high, but few understand their real human causes. One root cause lies in human raising awareness and upskilling. As example, national climate change literacy rates range from just 23% to 66% of the population across 33 African countries (Simpson et al., 2021).

Our proposition is to support the shelter response using digital and green technologies, thus shifting from a paradigm of reaction to anticipation (even to optimisation) and enabling earlier, faster, and potentially more effective humanitarian action (OCHA, 2021). Learning from past experiences, decision-makers could indeed analyse a new event with information that includes architectural knowledge in a clear and organized manner based on multi-modal data analysis (Comes, 2021). This comprehensive and balanced based green and digital technologies toolkit, will systematically equip, assess, simulate, and optimise humanitarian constructions decision making, by upskilling and empowering targeted populations towards green transition.

One green and digital technology that can be used and in substance important source of information is Earth Observation (EO) data. Satellite data are already available for many decades, but recently more and more satellites have been (and will be) launched with a very high spatial resolution of 0.1-4 m like the Planet Scope family (Frazier et Hemingway, 2021). Satellite data provides objective and repeatable information on land cover, land cover change and allows for analysis of impacts of climate change or anthropogenic activities on the land cover (Pickering et al., 2021) [10]. With respect to humanitarian habitat, remote sensing can provide on the one hand valuable information for the installation planning and on the other hand data to monitor the impact after installation.

[1] https://neatplus.org/
[2] https://www.qsand.org/
[3] https://sheltercluster.s3.eu-central-1.amazonaws.com/public/SMAC%20User%20Guide.pdf

One challenge is to increase the ability to access and use EO data is the development of human capacities (i.e., educating and training people to access and use EO resources) (Giuliani et al., 2017) and affinity for the technology (Franke et al., 2019; Wessel et al., 2019) and EO can be used as educational tool (Sarti et al., 2010) to enhance human values regarding environment (Bouman et al., 2018).

We present an original inductive research based on exploratory data analysis from Earth Observation. Discovery, exploration, and empirically detecting of phenomena in data can indeed contribute to inductively detect patterns rather than its role in other aspects of data analysis (e.g., model building, locating outliers, transformations) (Jebb et al., 2017). Induction concerns generalizing results beyond the observations at hand and open[s] the door to new insights and can illuminate phenomena that are of significant practical importance (Woo et al., 2017).

From exploratory field evidence produced thanks to EO (part 1), we will develop benefits and challenges (part 2), and as well perspectives to address the challenge of improving the human responses to climate change in Africa and optimising humanitarian constructions decision making, by upskilling and empowering targeted populations towards green transition.

1. Field evidence of humanitarian habitat impact on environment

Climate change has a significant impact on land cover and associated resources and is leading to increased occurrences of extreme weather events such as heavy rainfall or droughts. As a result, vital resources like water can become scarce, and the establishment of a humanitarian habitat may exacerbate this scarcity. High resolution remote sensing data gives information on land cover change. We present two examples on the potential of remote sensing data and how these data can support the selection of suitable locations for a shelter installation or monitor the impacts after installation.

In Figure *1*, we present three images from PlanetScope SuperDove with 3m spatial resolution depicting the month of October in the years 2020, 2021, and 2022 as a false colour image. The contrasting water bodies across these years demonstrate a substantial difference in surface water, highlighted by the yellow change layer. The shelter was opened Jan 2022 and is marked with a blue box. By analysing the satellite images, it remains unclear whether the shelter installation directly caused this change of water level or different rainfall patterns or amounts are responsible. However, in the scenario of limited water availability, the additional settlement could intensify competition for water as a finite resource.

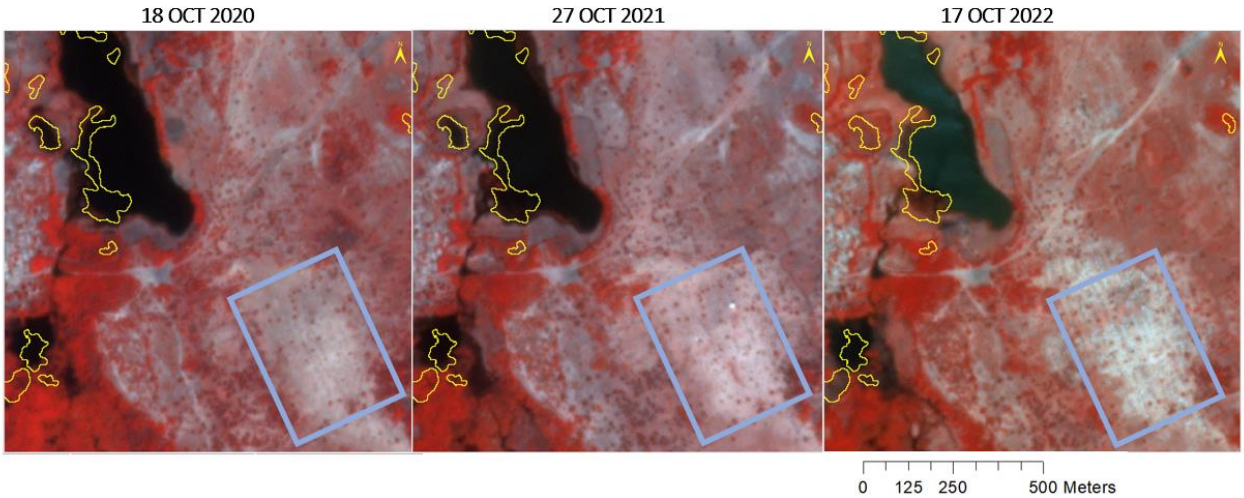

Figure 1: False colour visualization (RGB=>NIR-Red-Green) of a PlanetScope Superdove image. In yellow a change detection algorithm marks the main difference between the years 2021 and 2022.Water appears black and the decrease the size of the lake can be seen in 2022. The blue box shows location of the humanitarian habitat, which was opened in Jan 2022.

Figure *2* shows the comparison of two years close to a humanitarian habitat. A reduction in tree density is marked with blue lines. Whether this decrease of tree cover is related to the shelter construction, or another event cannot be concluded by exclusively using remote sensing data, but the tree cover change can be observed. It shows the general potential of high-resolution optical satellite data to monitor land cover change which might be introduced or impact humanitarian habitats.

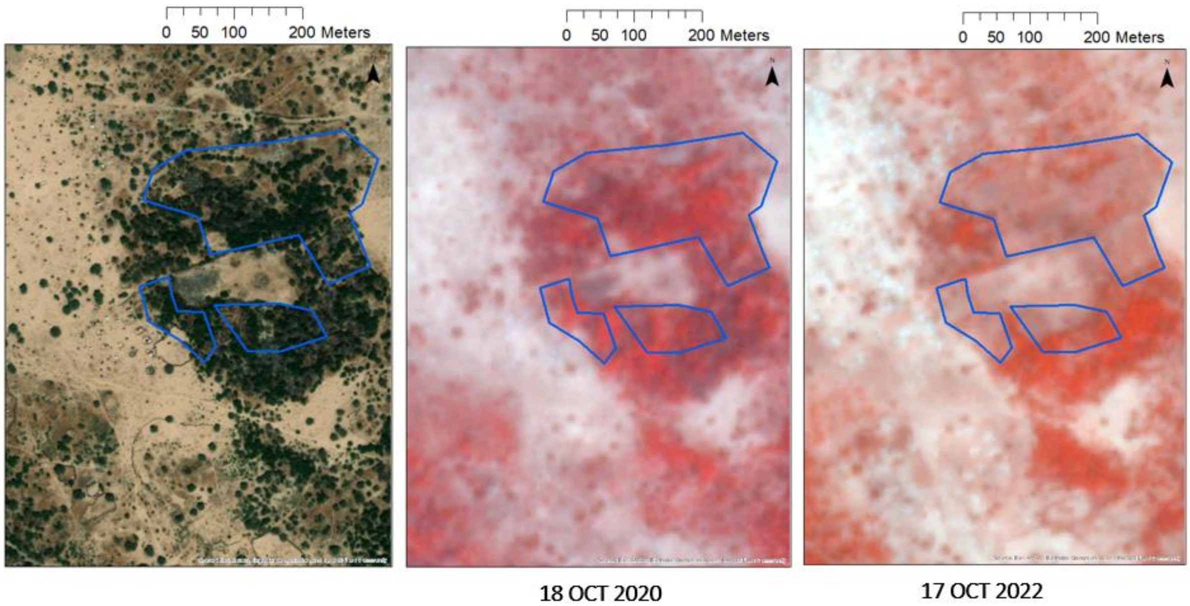

Figure 2: False colour visualization (RGB=>NIR-Red-Green) of a PlanetScope Superdove image. Vegetation appears in red and the image from 2022 shows a clear decrease of tree density. The image on the left is a very high resolution image provided by Esri with unknown acquisition date.

2. Benefits and challenges of EO for greening the shelter response and human upskilling.

2.1 Benefits of EO for greening the shelter response and human upskilling

First, EO helps bridging the gap between large volumes of data and the humans for better decision-making. It helps transforming raw data into information and knowledge by translating expert knowledge into workflows using interoperable processing services used to tackle key environmental challenges (Giuliani et al., 2017). Traditional data sources have indeed administrative and technical limitations, in terms of data access, standardisation and quality, lack of awareness concerning the benefits of current technologies, lack of financial resources, technology and skills gaps, geographical constraints (in terms of developing space projects), and coverage gaps across space and time (Andries et al., 2017). For instance, estimating the past vulnerability of a region to climate change can help select appropriate locations for the humanitarian habitats. Moreover, monitoring the impact over the years following installation can help identifying current or potential resource scarcities and locating problematic areas, such as the accumulation of plastic waste. Retrospective monitoring of already installed shelters can provide valuable insights into their impact and potential issues in their close to distant surroundings. This information can then be used to develop strategies on how best to utilize such data to formulate and educate strategies for reducing environmental impact. One potential example of a suitable strategy could be the identification, mapping, and recycling of plastic.

Second, EO has tremendous potential of education to raise humans' awareness on environmental issues. While EO is supporting the decision makers, it is also important to start preparing the new generation on the use of EO to limit human negative impact on the planet. As example, ESA's Eduspace programme is in the form of a website for secondary schools aiming to provide students and teachers of Europe and around the globe with tools for teaching and learning. In addition, ESA-Eduspace offers an entry point to satellite EO data and software applications for training. It encourages teachers to use EO data in their curriculum by providing ready-made projects (Sarti et al., 2010). One aspect of education is indeed the understanding and analysis of remote sensing data. These data and methods can serve as visualization and educational tools to help us understand how climate change is impacting land cover, as illustrated in Figure *1*. Additionally, land cover maps can support the comprehension of ecosystems and their interactions with human activities. In our research on humanitarian habitats, remote sensing-based land cover mapping and monitoring can have a significant impact on various planning and educational aspects in line with the Greening Education Partnership[4], which is to green communities, meaning "engaging the entire community by integrating climate education in life-long learning, in particular through community learning centres and learning cities"[5]. In this perspective, EO can contribute to enhance human values regarding environment, meaning for example, a change in individuals environmental believes and behaviours from a biospheric perspective (i.e., concern for the environment) to hedonic values (i.e., concern for pleasure and comfort), including altruistic (i.e., concern for others) and egoistic (i.e., concern for personal resources) values (Bouman et al., 2018).

2.2 Challenges of EO for greening the shelter response and human upskilling

The main challenge underlined by Giuliani et al. (2017) is the development of capacities at three levels: 1) Human: how to educate and train people to access and use EO resources, 2) Institutional: how to foster the use of EO to enhance decision-making, 3) Infrastructure: which hardware, software, and technology are required to access and use EO resources. By developing such capacities in remote sensing, humans will be able to provide guidance on the interpretation of imagery presented in EO systems and enhance the relevance of EO to support decision-making.

The second challenge, connected to the first, is the affinity to the technology, meaning whether users tend to actively approach interaction with technical systems or rather tend to avoid intensive interaction with new systems. It will measure personality traits related to EO enthusiasm, anxiety regarding the technology, the control beliefs in dealing with it, as well as technical problem-solving success, technical system learning success and device usage (Franke et al., 2019; Wessel et al., 2019).

[4] https://www.un.org/en/transforming-education-summit/transform-the-world
[5] https://www.un.org/en/transforming-education-summit/transform-the-world

Conclusion

Using an inductive approach, we propose from field evidence, research tracks regarding the use of EO to turn humanitarian habitat environmental impact in positive way. We discover EO's potential in better decision making and education, long as human upskilling and technology adoption challenges are addressed.

It is indeed important to ensure social aspects[6] thanks to a process of beneficiaries'/ users' upskilling. Recent UNESCO findings reveal that around half of the 100 countries reviewed had no mention of climate change in their national curriculum. This shows the disconnect between what learners are being taught and the reality that we are all witnessing in every part of the globe[7]. To answer this education challenge, a new Greening Education Partnership was launched in 2022. It aims to deliver strong, coordinated, and comprehensive action that will prepare every learner to acquire the knowledge, skills, values, and attitudes to tackle climate change and to promote sustainable development. More specifically, Luxembourg aims in particular, "at ensuring a minimum level of livelihood, in a rights-based environment, and creating equal opportunities for all, particularly for the most vulnerable and unprivileged, so everyone can actively determine the course of their own lives"[8].

Our research perspective is to extend the survey of digital and green technologies, which can contribute to the design of a comprehensive and balanced based green and digital technologies toolkit, that will systematically equip, assess, simulate, and optimise humanitarian constructions decision making, by upskilling and empowering targeted populations towards green transition. Recycled Plastic Brick (RPB) [21], 3D printing in Shelter [22], polyformer to turn water bottles into 3D printer filament [23] or AI are ones in the pipeline.

[6] https://emergency.unhcr.org/emergency-assistance/shelter-camp-and-settlement/shelter/shelter-solutions

[7] https://www.unesco.org/en/articles/connected-inclusive-and-green-how-unesco-wants-transform-education

[8] https://cooperation.gouvernement.lu/dam-assets/politique-cooperation-action-humanitaire/documents-de-reference/strat%C3%A9gie/Strat%C3%A9gie-MAEE-EN.pdf

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