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Slavery from Space: Demonstrating the role for satellite remote sensing to inform evidence-based action related to UN SDG number 8

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ABSTRACT

The most recent Global Slavery Index estimates that there are 40.3 million people enslaved globally. The UN's Agenda 2030 for Sustainable Development Goal number 8, section 8.7 specifically refers to the issue of forced labour: ending modern slavery and human trafficking, including child labour, in all forms by 2025. Although there is a global political commitment to ending slavery, one of the biggest barriers to doing so is having reliable and timely, spatially explicit and scalable data on slavery activity. The lack of these data compromises evidence-based action and policy formulation. Thus, to meet the challenge of ending modern slavery new and innovative approaches, with an emphasis on efficient use of resources (including financial) are needed. This paper demonstrates the fundamental role of remote sensing as a source of evidence. We provide an estimate of the number of brick kilns across the 'Brick Belt' that runs across south Asia. This is important because these brick kilns are known sites of modern-day slavery. This paper reports the first rigorous estimate of the number of brick kilns present and does so using a robust method that can be easily adopted by key agencies for evidence-based action (i.e. NGOs, etc.) and is based on freely available and accessible remotely sensed data. From this estimate we can not only calculate the scale of the slavery problem in the Brick Belt, but also calculate the impact of slavery beyond that of the enslaved people themselves, on, for example, environmental change and impacts on ecosystem services – this links to other Sustainable Development Goals. As the process of achieving key Sustainable Development Goal targets will show, there are global benefits to ending slavery - this will mean a better world for everyone: safer, greener, more prosperous, and more equal. This is termed here a Freedom Dividend.

1. Introduction

The Global Slavery Index (GSI) defines modern slavery in terms of "situations of exploitation that a person cannot refuse or leave because of threats, violence, coercion, abuse of power or deception" (GSI, 2016; page 158). The most recent estimate from the GSI (2017) indicates that there are currently 40.3 million people enslaved globally, including more than 30 million slaves in the 22 Organisation for Economic Co-operation and Development (OECD) Development Assistance Committee (DAC)-list of recipient countries for which there is uniform, comparable, representative data (www.globalslaveryindex.org). In recognition of the need to address this situation, the United Nations' Agenda 2030 for Sustainable Development Goal (SDG) number eight which refers to the provision of 'decent work and economic growth' by specifically promoting full productive employment and decent work for all people (United Nations, 2016a), has an addition, section 8.7 (which was adopted as a SDG in 2015), which specifically refers to the issue of forced labour. Section 8.7 aims to end modern slavery and human trafficking including ending child labour in all forms by 2025 (United Nations, 2016b). This is a global target that requires all nations to put forward assets and people in order to eradicate slavery once and for all.

There is a global political commitment to ending slavery, however, accurate information on slavery activity is not easy to come by and as such is one of the biggest barriers to a successful end to slavery. Therefore, what is required in the pursuit to meeting SDG 8.7 is reliable, timely, spatially explicit and scalable data on slavery activity. The lack of these data compromises

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evidence-based action and policy formulation. Thus, to meet the challenge of ending modern slavery, new and innovative approaches, with an emphasis on efficient use of resources (including financial) are required. The potential of remote sensing to inform efforts to tackle humanitarian issues, including slavery, has been noted (Bales, 2007:163). Indeed, a range of humanitarian issues have been shown to benefit from remote sensing, including poverty studies (Jean et al., 2016; Watmough et al., 2016) and supporting international peace and security (Jasani et al., 2009). Further, the Harvard Humanitarian Initiative, a unique system-wide network dedicated to improving humanitarian performance through increased learning and accountability, has recognised the added value of remotely sensed data (http://www.alnap.org/). Amnesty International are purchasing medium to high resolution imagery from satellite companies and then employing analysts to assess what the images are showing as a visual investigation for areas that are inaccessible to humanitarian and human rights organisations – they have created a programme for imagery analysis for human rights issues: Science for Human Rights Programme for Digital Globe (www.amnesty.org/). There is significant benefit to be gained from conducting assessments of human rights abuses using high resolution satellite remote sensing in particular, and this combined with eye-witness accounts from the ground can be extremely useful. These benefits are manifest in helping to track abuses and identify crises, as well as hopefully leading to the prosecution of those carrying out the abuses (Lavers et al., 2009) or enabling fast responses to humanitarian crises when they occur (Piesing, 2011; Witharana et al., 2014). Other work, still in its infancy but specifically looking at slavery, includes the mapping of fish farms suspected of using forced labour in the Sundarbans National Park (McGoogan and Rashid, 2016). The use of remote sensing for the detection of slavery activity is clearly a potential application area ripe for exploration.

In this paper we build on the aforementioned potential and present for the first time an estimate of the number of brick kilns across the so-called 'Brick Belt' region of south Asia. The focus on brick kilns is important since they are known sites of modern-day slavery. Research points to the ongoing and widespread abuse and exploitation of brick kiln workers, including children, and situations of forced labour, with many trafficked into situations of bonded labour slavery. The workforce in these kilns are predominantly migrants and from socially excluded and economically marginalised communities. A lack of both relevant preventative action and prosecution means that little is being done to prevent such practices (Bales, 1999, 2005; Kara, 2014; Khan and Qureshi, 2016). Although there are regional estimates of the number of brick kilns and thus slaves working within them, the full scale of the number of brick kilns and, by proxy, slavery is unknown. For example, the NGO Anti-Slavery International, reports that the National Sample Survey Organisation (NSSO) estimated that in 2009–2010, brick kilns employed more than 5% of India's 460 million workers; which would equate to more than 23 million brick kiln workers, with an estimated ~70% of the labour force in these kilns working under force. Others have offered estimates regarding the number of children who work under conditions of debt bondage, including within the brick making industry; Save the Children (2007) suggests that there are '250,000 children' who are living and working in Pakistani brick kilns. This is part of the enslaved workforce that means Pakistan can produce 8% of the world's bricks (Baum, 2010) as they take on a number for jobs within the kilns such as mixing mud, collecting water, carrying bricks and helping to fire them (Bales, 1999). This statistic is further supported by the International Labour Organisation (2005) report which found that around 40% of all brick kiln workers (both children and adults) within the Punjab region of Pakistan are working within bonded labour practices.

In this paper an initial step in providing data needed to inform action is presented. High resolution satellite remotely sensed data are used to make a rigorous and credible estimate of the number of brick kilns across the 'Brick Belt', using a straight-forward and reproducible method – based on freely available and accessible satellite data that will facilitate future work and the monitoring of progress in addressing the UN's SDG number 8.

2. Study area

The brick making industry is a large part of the development of the infrastructure and economy within these nations (Hawksley and Pradesh, 2014) and production appears to be increasing to cope with demand for building material (Baum, 2010). The areal extent of the 'Brick Belt' is 1,551,997 km^2 and crosses country and regional borders, thus calling for the use of a method of study such as remote sensing that can freely cross such boundaries. The core aim of this paper was to provide an estimate of the total number of brick kilns in the 'Brick Belt'. However, in achieving this goal we also wished to provide evidence to support the quality of the estimate derived. To do this we also study in detail a small region, an area of 250 km^2 in the northern Indian State of the Rajasthan. Ground intelligence from NGOs informs that a high occurrence of brick kilns exist in this region. The 'Brick Belt' itself is an unofficial region of Pakistan, northern India, Nepal and Bangladesh, that encompasses a large proportion of the brick kilns that can be found globally (Fig. 1).

There are several types of brick kilns that can be found in different areas of the world, however, there is one dominant type that can be found within the 'Brick Belt' and that is the large oval kiln (perimeter of around 217 m), known as the Bull's Trench Kiln (BTK); it is these BTKs that are the most likely to use an enslaved workforce (Bales, 1999) due to their sheer size (Patil, 2016).

3. Data and methods

A methodology was adopted based on high resolution satellite data provided by the geographic browser Google Earth. The open access satellite imagery provided has been used in a considerable number of studies and has many virtues for the study of the Earth's surface at a range of scales (Yu and Gong, 2012; Bastin et al., 2017). As stated already, the brick kilns are large, particularly with respect to the spatial resolution of high resolution satellite data such as WorldView, Pléiades, GeoEye-1, and QuickBird. Moreover, the kilns have a distinct spectral and spatial form and are thus readily visible on the high resolution colour satellite data available in the Google Earth geobrowser. Examples of different kiln types can be seen in Fig. 2. In this study, brick kilns were identified via visual interpretation of the imagery - the most recent satellite data from the geobrowser were used and the locations of fully formed kilns were mapped. The date range of the high resolution RGB imagery used (captured by WorldView-2 and Pléiades-1A/1B satellites, with a spatial resolution of 0.46 m and 0.5 m respectively) was between 05/11/14 and 03/12/16.

In order to generate an estimate of the number of brick kilns across the entire 'Brick Belt', a sampling approach was adopted as it was impractical within this study to undertake a complete survey of the entire region. A rigorous means to obtain a statistically credible and unbiased estimate of the number of kilns is to base the analysis on a probability sample drawn from the study region (Cochran, 2007). With little prior knowledge on the likely locations or abundance of brick kilns in the region a simple random sampling based approach was adopted in order to yield a credible estimate of the total number of kilns in the area. A grid of 100 km^2 square cells was overlaid on the 'Brick Belt' and a sample of grid

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