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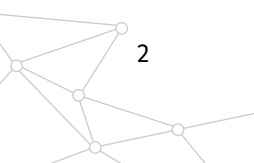
Data, drones and digital storytelling

An overview of opportunities for strengthening extractive governance
with digital tools

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List of abbreviations

ASM	Artisanal and Smallscale Mining
CSO	Civil Society Organisation
DLT	Distributed Ledger Technology
DRC	Democratic Republic of Congo
EITI	Extractive Industries Transparency Initiative
ESTMA	Canada's Extractive Sector Transparency Measure Act
GOTS	Global Object Tracking System
GRA	Global Rights Alert
ICT	Information and Communications Technology
ICTA	Institute of Environmental Science and Technology
IoT	Internet of Things
JARUS	Joint Authorities for Rulemaking on Unmanned Systems
ISEM	Indigenous Socio-Environmental Monitoring
LIDAR	Light Detection and Ranging
MEMS	Micro-Electromechanical Systems
MIT	Massachusetts Institute of Technology
MOOC	Massive Open Online Courses
NAPR	National Agency of Republic Registry (Republic of Georgia)
NFC	Near Field Communication
NGO	Non-Governmental Organisation
NRGI	Natural Resource Governance Institute

- OER** Open Education Resources
- OGP** Open Government Partnership
- RFID** Radio Frequency Identification
- RTLS** Real Time Location System
- RTSS** Real Time Sensing System
- SDG** Sustainable Development Goal
- UAV** Unmanned or Unpiloted Aerial Vehicle
- USAID** United States Agency for International Development
- USGS** United States Geological Survey
- VR** Virtual Reality

How are technological trends making extractives governance simpler, more inclusive, and more effective?

Few sectors have the transformative potential of extractives, particularly in emerging economies. Well-managed natural resources can catapult a country's growth, infrastructure and development to the next level. Mismanaged, however, they can erode institutions, benefit only a few privileged, and even fuel conflict. The better the governance of the extractives sector, the better the chance that citizens, companies and governments can all work in concert to realise the shared vision of a better world, as mapped out by the Sustainable Development Goals.

The extractives sector has had its fair share of reputational difficulties in modern history. Opaque ownership arrangements, a lack of transparency around revenue and payments, the under-representation of communities impacted by extractive activities, and unsafe or exploitative practices have all negatively impacted perceptions of the sector. They have also hampered its contribution to growth and development, particularly in emerging economies.

The good news is that the pace of positive change around some of these challenges is accelerating. Technology is playing a critical role in this, and we are all witness to the ingenuity of the digital revolution. The internet and digital tools are changing the world – including the extractives industry.

In order to harness technology's potential successfully and translate it into enabling policy and sound laws, we first need to understand the current landscape. We need to understand how digital tools can contribute to a more just and equitable extractives sector, for everybody. We need to test if and how technological trends are making extractives governance simpler, more inclusive, and more effective. We need a frank assessment of the limitations of these tools. And we should identify practical ways to support further positive change.

I would like to invite you, the reader, to read and enjoy this report, 'Data, Drones and Digital Storytelling', which we believe goes some way in exploring these themes. The report seeks to address three questions in particular:

- Which digital tools are making an impact on extractive governance?
- How are they making an impact?
- What opportunities and challenges exist for further exploration?

Like any revolution, it is not possible to predict the consequences of the developments currently taking place. It will take time and experience to grasp the long-term impact and implications of these technologies. There is, nevertheless, an urgent need to begin crafting enabling policy around digital tools and their role in strengthening governance for the extractives industry. This is a call to action we hope leaders across the extractives sector will answer, and we hope that this report can support them on that journey.



Mr. Andreas Proksch

Executive summary

Harnessing technological developments for social good is one of the great opportunities of our time. The extractives industry has often been characterised by significant imbalances in knowledge and skills, with well-resourced companies on the one hand, and citizens and their governments on the other. This has made effective governance of the sector more challenging, to the detriment of many actors in the extractives value chain, and for the planet itself.

Rapid advances in technology open up the possibility of reshaping access to information and strengthening accountability. Both emerging and existing technologies can disrupt old power structures, give voice to the previously voiceless, and democratise data. Inspired by this potential for positive change, 'Drones, Data and Digital Storytelling' provides an overview of seven digital tools or developments and their application in the extractives sector. These are as follows:

- Online repositories of data
- Drones and satellites
- Citizen participation via digital platforms
- E-learning
- Gamification
- Blockchain and distributed ledger technology, and
- The Internet of Things

Some of these technologies are already relatively mature, such as the growing number of repositories housing extractives data on the internet. These data are driving greater transparency about revenues, ownership and performance of the sector, and we are seeing a second wave of data 'infomediaries' who are collating and visualising extractives data in new and innovative ways. This flood of open data can inform sound decision making, focus policy, and strengthen oversight of the sector. E-learning is also becoming increasingly sophisticated, bringing down the physical and cost barriers to skills acquisition that existed in the past.

Drone and satellite technology is not new, but it has become more affordable over the last few years, which has broadened its usage and reach. Blockchain technology and gamification have arrived on the extractives scene comparatively recently, but are quickly being explored to effect change in the sector, although their actual impact still remains to be seen.

We encourage readers of this report, regardless of their sphere of influence, to consider how these digital tools can be used to enhance governance and oversight for the extractives industry further. This might take the form of partnerships, policy proposals, research or civil society initiatives. Each one of these digital tools represents opportunity, and the time to realise their promise to deliver a more transparent and accountable extractives sector, for all stakeholders, is now.

The bigger picture

How strengthening extractives governance with digital tools supports the Sustainable Development Goals

The 17 Sustainable Development Goals (SDGs) are a global call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. With that, the SDGs set out the bigger picture clearly, and set out targets we all need to work towards.

Mining and oil and gas have the potential to catalyse major development by generating significant revenues for the host country. That catalytic potential cannot be realised without the fundamentals of good governance being in place – strong institutions, transparency, just taxation regimes, inclusive processes and clear legal frameworks. Many of the SDGs’ focus areas, such as addressing economic inequality, encouraging innovation, ensuring sustainable consumption, and promoting peace and justice for all, have a clear link to the extractives industries for this reason.

For a more general overview of how the extractives industry can contribute positively to the SDGs, there is the [Mapping Mining to the Sustainable Development Goals: An Atlas](#), which was published in November 2016. The Atlas details precisely the areas where mining can contribute to the achievement of each of the 17 SDGs.

Major Issue Areas for Mining and the SDGs



Abbreviations:

- EIDs emerging infectious diseases
- OSH occupational safety and health
- TVET technical, vocational, and educational training
- CCS carbon capture and storage
- IFFs illicit financial flows
- FPIC free, prior, and informed consent
- PPPs public-private partnerships

adapted from Global Goals (www.globalgoals.org)

Unlike the Atlas, this report's focus is one particular aspect of strengthening extractives governance, digital tools and their application, and it extends to include the extractives industry more broadly, such as oil and gas, in some instances. But the findings in 'Data, Drones and Digital Storytelling' complement the 2016 Atlas, and build on its logic. The digital tools discussed in this report can contribute positively to many of the SDGs, but linkages to three SDGs are particularly salient.

Sustainable Development Goal 1: End Poverty

The extractives industry can contribute to eradicating poverty through tax and royalty payments that allow the development of basic public goods, such as access to health, housing, education and infrastructure. Digital tools to improve transparency around revenue payments include mandatory public disclosure of data in online repositories, which in turn can enable accountability and inform better governance.



Sustainable Development Goal 9: Industry, Innovation and Infrastructure

Digital innovation in the extractives space is in evidence throughout this report – the use of drone technology to record visual baselines or the introduction of educational games, for example. Using Blockchain technology to address the challenge of conflict minerals is another example. These illustrate the potential for the sector to contribute positively to the upgrading of technological capabilities, for the benefit of all.



Sustainable Development Goal 16: Promote Peaceful and Inclusive Societies

SDG 16 stresses the need for accountable and inclusive institutions at all levels, which are also fundamental building blocks for a well-governed extractives sector. Many of the digital tools shared in this report open up access to voices that might have been previously marginalised and allow government institutions to better monitor compliance of the sector. Digital platforms for citizen participation are being used innovatively in the extractives sector. Building knowledge and capacity through e-learning also strengthens institutions, and empowers citizens and civil society to better hold extractives companies and governments to account.





1. Online repositories of extractives data

A wealth of open data has changed the extractives sector

A trove of data relating to the extractives sector has been published in recent years. Publicly available information is increasingly being used by citizens and governments to strengthen oversight of their country's natural resources. While demands for data originally focussed on transparency around taxes and revenue, they have now expanded to include issues such as beneficial ownership, social impact and supply chain management.

The escalation of emerging extractives data has the potential to reduce an inequality in access to information that often arises between governments, civil society actors and extractives companies. Crucial ques-

tions about whether an extractives company is paying the right amount in tax, a government negotiated a good deal for its people or how governments are spending the revenues they receive from the sector, can be better explored with supporting evidence in the form of data. The advantages of access to open data are clear. By making datasets freely available in online repositories, citizen and community participation becomes more likely, sectoral trend analysis easier, and instances of suspicious actions on the part of both companies and governments harder to obscure. All of these together strengthen oversight and enhance governance.

The original initiatives driving the publication of extractives data

The Extractive Industry Transparency Initiative (EITI)

The EITI has driven the publication of revenue data in the extractives sector, arguably more than any other initiative. The EITI is a global standard under which governments commit to disclosing key information about their natural resources, including on revenue payments and receipts, production, exports and how

contracts are allocated. The range and accessibility of EITI data is set to increase and improve further in the coming years, particularly when the May 2017 changes to the EITI Standard come into effect. These will focus on beneficial ownership. The Standard encourages the publication of other pertinent data, such as extractives contracts, and requires all countries to publish the beneficial owners of extractives companies by 2020. EITI's open data policy, which requires countries to

publish data in open data formats, came into force on 31 December 2017, while there has recently been a push to make published data available through existing corporate and government systems such as databases and portals. Notably, several countries have exceeded the Standard's requirements and used EITI to disclose a range of relevant natural resource data, such as Colombia, whose 2016 EITI report included information on environmental licences and fees paid to the environmental regulator.

The Open Government Partnership

Launched in 2011, the Open Government Partnership (OGP) is a multilateral initiative that encourages governments to promote transparency and enhanced governance. More than 70 countries and 15 sub-national governments are currently participating. The OGP has both helped reinforce governments' existing commitments to disclosing extractives data and helped increase commitments to data disclosure in key areas such as beneficial ownership, contracts and social-environmental indicators.

Mandatory revenue disclosure laws around project-level data

In 2010, the United States adopted the Dodd-Frank Act. Of particular relevance was Section 1504 of the Act, also known as the Cardin-Lugar amendment. This required all US-listed oil, gas, and mining companies to declare the payments they make to governments where they operate. These payments include taxes, fees, bonuses, and in-kind payments, disaggregated by project. Dodd-Frank 1504 helped pave the way for similar legislation around the world, including the European Union, Norway, and Canada. Switzerland and Ukraine are considering similar laws and in October 2017, the Australian government announced its intention to adopt mandatory disclosure rules. Since 2015, payments from 500 companies from 13 reporting jurisdictions, covering more than 3,500 projects, have been disclosed.

There has been some regression on this front in the United States in recent years. No data from US-listed companies was ever published under Dodd-Frank 1504. The implementation of the law was delayed by many years as a result of legal challenges and rules delays, and Section 1504 later attracted heavy criticism from the new Republican administration. The American Congress repealed **Dodd-Frank Section 1504 in June 2017** before first disclosures were due in 2019, and the rule has now been discontinued.

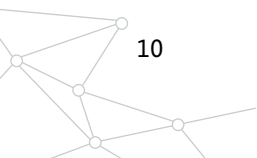
The second wave: extractives 'infomediaries' emerge

With more information becoming available, data curators (or 'infomediaries') have become more common. These intermediary actors have begun processing extractives data so that it can be more easily accessed and used by others. Such actors sometimes visualise and contextualise data to make it more user-friendly, and sometimes combine, match and compare datasets to demonstrate trends or contrasts. For example, information on beneficial ownership, corporate structures, or lists of sanctioned or politically exposed persons can be matched to company payment records. They can also help as interpreters for complex or emerging digital tools such as Blockchain or Distributed Ledger Technologies, where the new user's understanding

might be relatively basic – see later in this report for more information on these digital innovations.

An (incomplete) list of such extractives data curators follows below:

- The **Resource Contracts Platform**, developed by the National Resource Governance Institute (NRGI) includes explanatory annotations and enables searches by resource, country or contract term.
- **Resource Projects**, also produced by NRGI, collects and cleans project-level data released through recent disclosure rules, currently housing information for



almost 600 projects in 124 countries. In addition, automated collection of data makes it more affordable.

- **OpenOwnership** is a global register of beneficial ownership that collates data from various sources, including the United Kingdom's Persons of Significant Control Register.
- **The Extractives Hub** is an online platform which collects all publicly available data sets on the extractives industries into one place (including from all the resources listed above). The Hub also generates eye-catching data visualisation of complex data sets.
- The **Extractives-led Local Economic Diversification (ELLED) Framework** is managed by the Energy and Extractives Global Practice of the World Bank. The ELLED Framework curates and shares existing knowledge to address extractives-related policy challenges, including local content policies, climate smart investment, strategic spatial planning, forward looking value chains, and the development of network economies.

How can online repositories impact extractives governance?

More digital data improves understanding of a complicated sector. Publicly available extractives data help improve natural resource governance by allowing citizens to better understand the sector and explore crucial questions such as whether a company is paying the right amount in taxes and how governments are sharing payments.

More datasets reduce the asymmetry of resources and information between governments and companies. This in turn can encourage citizen participation and oversight. The disclosure of extractives data helps bring instances of corruption to light, on the part of both companies and governments, and reduces opportunities for corruption. Citizen participation and oversight in how a country manages its natural resources can play out in a number of ways, from data-based advocacy to revenue tracking or project monitoring.

It can also help improve financial modelling. Open data on extractives governance has expanded beyond revenue transparency to include areas along the value chain, such as the awarding of mining, oil, and gas rights and contracts, and detailed project (or operation)-level data. This means that activities have evolved from just revenue tracking to preventing corruption and waste, to calculating (through financial modelling) whether countries are getting a fair deal for their resources.

What is financial modelling?

Financial modelling is a simulation tool to forecast a project's financial performance over its lifetime. It is usually built in an Excel spreadsheet, and relies on a number of assumptions. In the past, financial models were used almost exclusively by investors and companies with the training, skills and proprietary data to support the modelling process. But recently there has been a trend towards 'open' modelling on the part of governments and civil society actors, using publicly available data to make their own financial forecasts. Open modelling in the extractives sector uses information already available in the public domain, such as annual reports or data from the EITI. There are also examples of open financial models drawing on company contracts which have been published online, and project-level data, to forecast future financial performance.

Case Study

Liberia combines different datasets to estimate the impact on its economic growth

The non-profit organisation AidData, in partnership with the Concessions Working Group in Monrovia, has mapped Liberia's natural resource concessions and developed a dataset of all known natural resource concessions granted to investors in Liberia from 2004 to 2015. The organisation systematically categorised 557 concessions in 43 different dimensions, including the names and nationalities of the investors, the nature of the rights granted to these investors (exploratory or extractive), and the presence or absence of contractual commitments to undertake corporate social responsibility activities. By using geospatial impact evaluation methods and data from satellite imagery, weather stations, household surveys, and administrative records, the research team estimated the effects that different types of concessions and concessionaires have on local economic growth outcomes. All results are available in [an interactive map](#).

Case Study

Malawian financial modelling strengthens policy

During a financial modelling 'sprint' organised by the consultancy provider Open Oil, two Malawian citizens built a financial model of the Kayelekera uranium mine, using the mining development agreement and other data such as the mining company Paladin's annual reports. The mine halted production following the Fukushima nuclear disaster in Japan in 2011, and the model enabled participants to determine what the price of uranium would need to be to cover the costs of extraction again. This break-even price was more than double the price of uranium at the time. They also found that the government's reduction of royalty rates had caused US\$ 15 million in lost revenue and that a further reduction would not have a significant impact on the break-even price.



The analysis helped raise awareness of what factors would need to change in order for production to resume.

Case Study

A Ugandan CSO identifies missing US\$14 million

Global Rights Alert (GRA), a Ugandan civil society organisation, was struggling to find information on which pre-production payments the government was receiving from oil companies, as only patchy data was available from the Bank of Uganda. However, as a result of the European Union's Transparency and Accounting Directives, in 2016 the oil companies Tullow Oil and Total published the payments they had made to the Ugandan government. GRA was then able to analyse these figures and compare them to the Bank of Uganda reports. GRA **found that US\$ 14 million** had not been accounted for in the books. In their dialogues with the government they used this information to ask for an explanation. According to Winnie Ngaabirwe, a campaigner at GRA, the hard data enabled them to demand financial accountability and be taken seriously by the authorities, which in turn allowed for "in-depth and valuable" conversations.



Opportunities and challenges for online repositories of data

Case studies in this report illustrate how publicly available extractives data can be used to advance natural resource governance. As ever more data becomes available in the public domain – for example, through mandatory disclosure rules and changes to the EITI Standard – and as actors become better versed in how to use the data, resource governance will be strengthened.

Some significant gaps persist in publicly available data, however. The first area is commodity trading data, where the amounts paid to governments for the sale of physical gas, oil, and mining resources – are not covered by current mandatory disclosure rules. Another gap is social and environmental information. While the Global Reporting Initiative (GRI) has encouraged better environmental and social performance indicator reporting by extractives companies, there is scope for considerably more disclosure.

There is also room for improvements in terms of *how* data is being disclosed. Even government driven reporting requirements sometimes comes short of re-

quiring that data be disclosed in open format – namely, readily searchable and indexable, and not in a PDF or image format. Canada’s Extractive Sector Transparency Measures Act (ESTMA) and the European Union Accounting and Transparency Directives are two such examples. Open data is crucial for actors to be able to genuinely use and access data, and has become the battleground for extractives transparency campaigners.

As the case studies demonstrate, the analysis of extractives data is still complex and requires expertise to process large amounts of data. Although some civil society organisations (CSOs) have already assumed the role of data intermediaries, such as Publish What You Pay’s Data Extractors Programme discussed in the accompanying case study, there is a lack of comprehensive approaches to fostering this expertise in CSOs – specifically related to extractives data. There are tentative steps to improve this situation: for example, the EITI’s experiments with **Data Storyteller Bootcamps**, or applications that make EITI data much more comprehensible.

Opportunities

- **More datasets are becoming available.** There is a trend towards increased data disclosure, particularly as changes to the EITI (e.g. regarding open data and beneficial ownership) come into effect and as project-level payments are published annually under mandatory disclosure rules. The accumulation of data, year on year, will expand the possibilities for its effective use.
- **More detail is being included.** The revision of the European Union (EU) Accounting Directive in 2018 provides an opportunity to make important amendments to how project-level data should be disclosed, for instance by requiring that information be published in open data format.
- **Datasets are better curated.** In some cases, actors have adopted the role of ‘infomediary’ to help make available data more accessible and useful. This includes collating data from various sources and presenting it in one place as open data, or providing additional context and creating search functionality - see the section on Digital Campaigns, further on in this report.

Challenges

- **Many datasets are not in open format.** Most mandatory disclosure rules do not require data to be disclosed in an open format. As a result, many reports are released in PDF, which makes the data much more difficult to extract, process and compare.
 - **There are areas of confusion.** For example, in the European Union Transparency and Accounting directives, lack of clarity around how to report on joint ventures and a lack of consistency in how payment categories are presented can make it more difficult to ‘follow the money’.
 - **Important datasets are still missing.** Further disclosure in other data areas, such as commodity trading and social-environment information, is necessary to provide a more complete picture to inform improvements in natural resource governance through data.
 - **There have been regressions in transparency disclosures.** While transparency is becoming more broadly accepted by most stakeholders in the extractives field, there have been setbacks – notably the repeal of Dodd-Frank 1504 and US withdrawal from EITI. In the coming years, transparency advocates will have to demonstrate the benefits of data disclosure.
 - **Critical discourse is being curtailed in some countries.** Civic space for transparency campaigners has been shrinking in some countries, as their governments make it more difficult for civil society to express and organise itself, and fail to protect activists from reprisals by companies. Campaigners face a range of dangers including harassment, smear campaigns, and, in some extreme cases, death.
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2. Drones, satellites and geospatial data

In many ways the extractives industry is defined by its impact on the physical environment. Strategic use of geospatial data can support better monitoring of this important aspect of the industry's activities.

The practical uses for geospatial data are manifold. Governments can capture mineral resources and geology through remote sensing, and use this for their cadastres. The size and operations of mines and oil rigs can be mapped to ensure compliance to licence conditions. Environmental changes to vegetation, soil, water and animal populations can be documented to identify and mitigate risk. Human settlements can be noted with precision to strengthen planning and protect human rights.

There have been rapid technological improvements in aerial imagery in the last five years. In particular, data collected from satellites, high-flying aircraft, or drones (also known as unmanned aerial vehicles, or UAVs), have become significantly easier to obtain and more affordable. The increased volume and resolution of this data – combined with new methods of processing and analysis enabled by machine learning – have enabled opportunities to improve the governance of mining, oil, and gas activities using visual evidence, which was previously more difficult to obtain.

This section explores drone and satellite imaging technologies and their potential to assist actors across the extractives value chain, from government agencies and companies, to investigative journalists and civil society activists.

The key differences between drones and satellites

The primary difference between these two technologies is the image resolution. Images and footage from drones offer much higher resolution, and therefore much more detail (approximately 1 m² per pixel), than satellite images (approximately 100 m² per pixel). In agriculture, farmers could use a satellite to get a broad overview of many fields together, but a drone could do a tree-by-tree precision analysis of a remote area of the

farm. Drones also offer video footage, whereas commercial satellites generally only capture still photographs.

Drones are small and agile devices. They can be tightly controlled and directed to fly high or low, in a specific direction, or focus on a designated area. Satellites are much larger and relatively inflexible machines, with a

set, predictable routine for taking and transmitting images of the earth.

These differences have cost implications. Drone imagery is significantly more expensive than satellite imagery, although the cost of drone hardware is steadily

decreasing, making it more affordable. The software required to fly drones and process drone imagery is also becoming more readily available to the average user, reducing the expense involved in preparing and analysing data.

How can drones impact extractives governance?

The private sector already deploys drone imagery and data in the following areas:

- Better understanding of the mineral or oil and gas resources, and their potential value for exploitation, through mapping
- Closer monitoring of environmental impact by mapping licence areas (including at sea) for flora and fauna, water sources and tailings or waste management sites
- Improving responses in emergency situations by using drone images to quickly gather information – for example, to inspect oil pipelines or assess damage following oil spills or accidents
- Improved health and safety for workers by optimising productivity and safe use of equipment on sites and rigs, and improving technical failure prediction on extractives sites

Extractives companies are frequently better resourced than host governments, so there is an imbalance in access to drone data. With greater expertise and financial resources, and more agile procurement processes

to keep up with developments, private companies are often better positioned to obtain and use drone data to their benefit. While this imbalance in access to data is a challenge in several areas of extractives governance, it is particularly pronounced when it comes to drone technology. The private sector already deploys drones for a wide range of uses, while governments have been slower to deploy drone hardware or specialist skills, or to build drone data into their oversight mechanisms.

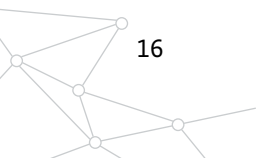
Nevertheless, strategic sharing and use of the geospatial data being generated by drones presents opportunities for more precise and accurate reporting by extractives companies, and better compliance monitoring by governments, for example:

- Strengthening governments' land policy by providing visual evidence of human settlements, resettlement and land use (farming vs. artisanal mining, for example) on licence areas
- Ensuring compliance with laws and regulations by monitoring stockpiles and warehousing in the mining industry, particularly where this is locally or internationally regulated (such as the London Metal Exchange's warehousing rules)

Capturing a visual baseline using drones

One of the most promising applications for drones in supporting good extractives governance is their ability to capture a visual baseline. A time and date stamped image or video of the area granted for an extractives licence can provide objective visual evidence against which the licence holder's performance can be checked in the future. The visual baseline supports

governments and citizens in monitoring and comparing physical impacts of an operation over time, provided it is comprehensively analysed and correctly annotated at the time the footage is taken. Making the submission of a visual baseline compulsory for extractives companies has not yet become the legal or regulatory norm, but warrants further consideration.



Since the focus of this report is extractives governance, three particular areas of interest for a visual baseline taken by drones are:

Monitoring environmental impacts on flora and fauna

Identifying and tracking the biodiversity and animal population, including marine life, in extractives licence areas has historically been onerous and difficult. Drone imagery is not able to capture detailed information, and can never substitute a thorough Environmental Impact Assessment (EIA). But it is a useful supplementary tool for noting the presence, quantity and location of plants, forests, ground cover and water sources in these areas. A visual baseline can assist with recording the occurrence of animals, particularly if any

are endangered, vulnerable to poaching or sensitive to environmental changes.

Monitoring human settlements and cultural heritage on land

Land is an extremely sensitive topic in any community. Mining companies are sometimes required to relocate communities so that they are able to mine the resource beneath their homes, or if their houses become unsafe. Resettlements are usually guided by local and international guidelines, but can become a fiercely debated topic, with considerable potential for conflict. Using drone imagery to analyse human settlements can support good and equitable decision-making when dealing with complex issues around land use and human rights.



Building public multipurpose cadastres for licence concessions

Typically, land cadastres are maintained as public registries by governmental institutions as a record of land 'parcels'. In the case of mining cadastres, information on licence concession areas tends to be limited to geological, legal, and economic attributes. The emerging concept of multipurpose cadastres, by contrast, includes much more data about the licence area in question. Multipurpose cadastres could contain additional

rich data about the environment, animal populations, water sources, transportation systems, utility networks and human settlements. Drone imagery can be used to help assemble these more comprehensive cadastres. Their benefits include better planning and stricter preconditions for granting extractives licences, and improved monitoring and evaluation of land use by extractives companies.

How can satellites impact extractives governance?

Satellite imagery has become widely available at a much lower cost in recent years, as small satellites ('smallsats' or 'cube-sats') are being released into space in increasingly large numbers. This means that the earth can be imaged in high spatial definition, and those images are easily available for commercial purchase. Most satellites image an area on a weekly basis, and improvements in quality are taking place continuously.

Scanners and cameras mounted on satellites orbiting the earth allow for Remote Sensing, a technological tool, which can be used to identify the presence of mineral resources. Aerial Light Detection and Ranging (or LIDAR), is a remote sensing method that uses light in the form of a pulsed laser to measure distances to the earth's surface. LIDAR can help to map a country's geomorphology by penetrating vegetation. These generate bare earth models, which can support mineral exploration projects. In other cases, it can be used to calculate flood risk or landslide risk – all relevant metrics for assessing the potential environmental impact of an extractives project.

For the public sector, the potential for machine learning can be very powerful in this regard: governments with restricted capacity or low budgets can potentially have some of this work automated by artificial intelligence on lower-cost satellite imagery, increasing their access to information dramatically without debilitating cost. Significant work is underway to apply machine learning and deep learning to satellite imagery. Commercial companies such as DigitalGlobe and Planet have begun to apply algorithms to satellite images to detect and classify objects, locate topographic and geographical features, and monitor changes over time.

Machine learning and satellite images are now being used for developmental purposes too. Stanford University has developed a **machine learning model** which is able to predict per capita consumption expenditure of a particular location when provided with its satellite images. The algorithm runs through millions of images of rural regions throughout the world. It then compares the presence of light in a region during the day and at night to predict its economic activity, which can then predict the relative wealth and/or poverty of the area. While still in its early stages, this same sort of mapping tool could become available for use in extractive governance in the future.



Tracking change over time using satellites

Photographs taken by satellites are useful for registering changes to an area over time, because they are regular, comparable and affordable. The applications for this digital tool are many and varied, and just a few examples are noted below.

Companies, governments, local communities or civil society organisations can use satellite images to monitor the environmental impact of a mine, and access supporting photographic evidence to seek redress if necessary. Satellite images could help to evaluate the growth of waste sites and tailings dams; or chart the progress of infrastructure projects over time, such as building roads or rail links, or pipelines in the case of

oil and gas. Multispectral satellite imaging (collecting data across the electromagnetic spectrum, including light that is both visible and invisible to the human eye) could also be used to measure vegetation health, and compared with previously captured imagery to demonstrate an extractives project's positive or negative impact.

Satellite imaging could also capture environmental degradation caused by artisanal or illegal mining, and can also provide regular updates on companies' land reclamation activities, to ensure they are meeting their closure obligations correctly and timeously.



Satellite images to focus on incidents

It can be expensive to send a drone to check on a specific incident repeatedly. In many respects, satellite remote sensing and aerial imagery have advantages for closely monitoring individual incidents. The World Bank has been using satellite imagery to identify and

monitor flaring of natural gas produced during oil extraction. Satellite imagery can also help to pre-empt problems in gas pipelines that may lead to future difficulties. Wildfires, floods, or oil spill clean-ups can also be closely tracked via satellite images over time.

Case Study

Monitoring the environmental impacts of mining via satellite in Chile

The Chilean Ministry of Mines and the Chilean National Mining Corporation have collaborated with a wide range of partners, including the United Kingdom's **Satellite Applications Catapult** initiative, to investigate how various types of satellite data could improve monitoring of the environmental impacts of mining. The platform, which was launched in April 2016, shows data on topics such as urban development and ground deformation. It also visualises aggregated data on a range of issues such as vegetation health and water deposits in a way that is intuitive and easy to use, even for non-technical users. The initiative aims to assess water and mineral deposits, monitor the environmental impact of mining activities, and help tackle organised crime. Read Innovate UK's case study on the collaboration [here](#). A subsequent project will promote the development of smaller mining companies in Chile's Coquimbo region by collecting satellite data that can show government agencies how best to support regional mining ecosystems.

Case Study

In just one hour, a USAID drone maps Guinea's artisanal mines

In June 2014, the US Geological Survey (USGS) worked with a USAID team to map artisanal diamond mining sites in western Guinea as part of efforts to formalise mining activities by identifying, estimating, and monitoring artisanal mineral extraction over time. Previously the USGS had been using satellite imagery to identify artisanal mining sites, but they were experiencing problems with the satellites. They were constrained by the low resolution of the images, cloud cover and haze, imagery that was not available regularly enough to capture the changing nature of artisanal mining sites – all of which prevented them from identifying features at the level of detail necessary.

As a solution, USGS deployed a DJI Phantom 1 drone over seven mining sites. This allowed them to collect a complete picture of the sites in under an hour, including areas that would have otherwise been inaccessible because of limited road access, dangerous terrain, and disturbances to the surface as a result of mining. With the new drone images, they were able to “clearly distinguish active pits from inactive pits, locate and measure piles of extracted gravel and sedimentary layers, and detect changes in water colour and sediment properties.” The imagery was also used in participatory mapping exercises with local communities to help formalise property rights by identifying mining and agricultural zones. As a result, the government gained information that could help it identify zones for formalised artisanal mining and defunct mine sites that could be used for alternative livelihoods such as fish-farming.



Opportunities and challenges for drones and satellites

A number of opportunities for innovative and high impact policy around aerial imagery and extractives governance are available to governments. Although it is sensible to exercise some restraint until the intended and unintended consequences of this new form of data are better understood, the field remains under explored and under regulated by the governments of resource rich developing countries.

Global efforts to harmonise drone regulations across countries are already under way. The JARUS (Joint Authorities for Rulemaking on Unmanned Systems) expert group is developing a single set of operational and technical requirements for certifying UAVs, which different

countries can use to develop their own UAV regulations. The [Global Drone Regulations Database](#) reflects all current existing regulations in one central place.

As noted earlier in this report, the private sector currently dominates the generation and utilisation of geospatial data in the extractives sector. As the hardware and software become increasingly advanced and accessible, however, a wider range of stakeholders will be able to conduct their own analysis. Machine learning is also likely to create cheaper, more sophisticated tools that governments can begin to use to bolster their governance and oversight role.

Opportunities

- **Satellite imagery and UAV technology has become cheaper and easier to access.**
- **Policy and regulation has not yet fully come to terms with aerial imagery.** Regulations governing the use of data collected by satellite and UAVs are still being developed in most countries. There is a rare opportunity for innovative thinking around policy, particularly in using this technology to enhance the extractives sector governance.
- **Governments can invest in purchasing their own drones and satellite imagery to support governance.** Rather than leaving this technology solely to the private sector, governments can proactively use aerial imagery to review the effects of extractives activity on the local population and environment and companies' performance over time.
- **Remote locations can now be viewed.** Drones and satellites can allow governments, citizens and companies to gather data in areas that would otherwise be inaccessible.

Challenges

- **Advanced analysis is expensive.** Sourcing, processing and interpreting high-resolution imagery data requires computers with adequate processing power and software, as well as staff with experience and technical skills.
 - **There are few ethical guidelines.** There is a need for agreement on standards for collecting and using aerial data ethically and responsibly.
 - **Communities can be wary of drones.** Invasive UAVs may be assumed to be military or intelligence drones or have other negative associations. Extractives projects and governments should aim to build strong relationships with communities where UAV flights take place, and encourage transparency around the use of data.
 - **Aerial imagery data should not be used as standalone evidence, but be accompanied and corroborated by other forms of data.**
-

3. Encouraging greater citizen participation via digital platforms

An ongoing challenge is the sometimes adversarial relationship between host communities around an extractives project and the operating company, as local citizens have to bear many of the externalised costs of extraction activities. In many cases, communities feel they are inadequately consulted about the arrival, establishment, operation and ultimate closure of extractive operations on their doorsteps.

In aiming to tackle this challenge, new digital platforms to gather feedback from the grass roots level are now enabling 'citizen reporting.' These digital channels have the potential to improve understanding and ease conflict between large-scale companies, the communities, which host them, and the governments which oversee both.

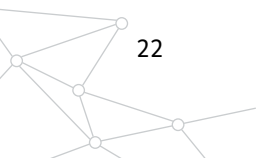
What is citizen reporting?

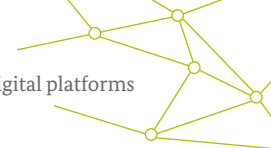
Citizen reporting is when citizens collect and analyse information about issues that affect them, which can then be used for analysis or advocacy to improve policy-making. By using web platforms and 'apps', citizens are better able to document events and developments, track progress, and draw attention to injustices. Their audiences may include politicians, corporations, civil servants, civil society or even the international community.

How can citizen reporting impact extractives governance?

Citizen reporting initiatives can collect data about the impacts of extractive sector activities that might otherwise remain unreported – or, if reported, are not adequately responded to by companies or governments. In an example from Nigeria, the **Tracka project**

gathers videos, photographs and verbal testimony from citizens documenting the grass roots impacts of government spending decisions. The project also offers citizens real-time updates on projects near them online and via text message.





Case Study

How a Spanish university is mapping resource conflicts using citizen inputs

The **Environmental Justice Atlas** is an initiative from the Institute of Environmental Science and Technology (ICTA) at the Universitat Autònoma de Barcelona. The Atlas maps conflicts globally, including conflicts related to fossil fuels and climate justice. Each resource conflict featured in the Atlas is accompanied by information on investors, notes on the impact of certain deals, and videos and pictures. The project collects information from non-governmental organisations, academics, and informal citizen groups. It also builds on existing databases such as the Brazilian public health institution FIOCRUZ's 'map of environmental justice', and moderates it before inclusion. The map is designed to act as a teaching aid and a means for organisations to share knowledge about successful strategies.

Case Study

Online volunteers crowd-source information about oil spills in the Niger Delta

In Nigeria, Amnesty International's **Decoders initiative** enabled online volunteers to help their researchers analyse six years of geospatial data on oil spills in the Niger Delta. More than 3,000 volunteers contributed 1,300 hours of their time (the equivalent of one person working full time for eight months) to identify trends and inconsistencies. Amnesty researchers conducted the initial analysis which was then verified by the independent pipelines expert Accufacts. The work revealed that oil companies were too slow to respond to reported spills, and that in some cases they had published misleading information about their causes and severity, potentially preventing communities from receiving compensation.

Opportunities and challenges for citizen reporting

Citizen reporting has not yet lived up to its expected impact. The level of impact has been more modest than many had hoped. Early implementers anticipated that providing individuals and communities with the opportunity to share and receive information about their own situation would foster greater transparency, prompting meaningful change and potentially improved governance.

However, recent research by the **Making All Voices Count (MAVC)** programme found that in many cases, transparency initiatives with a digital or technological component tended to overestimate the potential of technology to facilitate positive change. Common

weaknesses were programme design flaws and difficulty connecting with the right stakeholders – for example, affected communities, or the authorities which should be responding to the information.

A 2016 research paper also found that many technology-enabled initiatives improve government responsiveness to citizens' needs only when those governments are already actively seeking feedback from citizens. In other words, citizen reporting is not powerful enough to alter the social or political norms that prevent citizens' voices from being heard in the first place. A more promising approach may be for initiatives to integrate citizen reporting into a broader strat-

egy based on advocacy at multiple levels, and grounded in strong, mutually beneficial relationships with the people who are providing the data.

Opportunities

- **Valuable information is being gathered.** When part of a broader campaign operating at multiple levels, citizen reporting initiatives can generate, channel or curate valuable data.
- **More data interpreters are needed.** Supporting and investing in ‘infomediaries’ who can synthesise, translate, simplify, and direct information on behalf of others may, in some contexts, help to ensure that the collected information is used more effectively. Media or other civil society organisations can both help to serve this role.

Challenges

- **Better planning and design is needed.** Projects aimed at encouraging citizen reporting need to be designed based on an understanding of users’ needs and habits, as well as existing projects and tools that perform similar functions. To support such planning, resources do exist. **Alidade Tech**, an interactive tool for finding appropriate technology tools to help civil society organisations with their social change project, and the nine **Principles for Digital Development** are useful resources to support this process.
 - **Comparability and cross learning is still difficult.** There are well-documented limits to the extent to which citizen-generated data can be compared across regions, countries or sectors. This is due to differences in the way data types are conceptualised, documented, and shared. Addressing this would involve significant, long-term efforts to build capacity and generate support for shared data standards.
-

Digital campaigns: raising awareness through digital storytelling

What is a digital campaign?

Digital campaigns involve the distribution of information and messages to audiences using digital technologies. Digitisation has changed the way campaigns are designed and executed, as well as their reach. Digital campaigns can utilise many channels and formats, responding to the preferences of their audiences and the strengths of the material available to them. A story or campaign can be delivered simultaneously via Twitter or SMS, YouTube, Instagram and Snapchat. Previously only a small minority had the means to produce online campaigns, but the rise of smartphones and broader internet access has democratised the space.



Case Study

Global Witness shines a light on Myanmar's jade mining conflict

For thousands of years jade, with its vivid green colour, has been used to make jewellery, weapons and crafts. Today, according to the non-governmental organisation Global Witness, the jade mining business in Myanmar is a significant driver of an armed conflict. The war has claimed many lives and has, according to Global Witness, displaced 100,000 people since it reignited in 2011. In an **interactive, multimedia report**, Global Witness lets the user track key figures involved in the conflict and follow a timeline of events. It includes blog-like entries as well as videos and high quality photographs that bring to life the main issues and the stakeholders involved in jade mining in Kachin state. Their digital story-telling campaign is aimed at policy makers and proposes a range of sanctions for individuals who are explicitly named. The multi-media platform is accessible in English and Burmese and has enjoyed a wide reach. Since its launch in May 2017, more than 150,000 people have accessed the report.



global witness

Case Study

Oxfam's 2017 digital campaign in Bolivia fails to engage effectively

Oxfam's 2017 digital storytelling campaign in Bolivia provides valuable lessons about the challenges of achieving the desired uptake and engagement with digital campaigns.

Bolivia's Chaco region has a long history with the oil industry. The sector is required to engage with communities as part of environmental monitoring practices. In order to raise awareness about some of the issues involved in carrying out the monitoring activities, Oxfam created a **multi-chapter interactive video-campaign** on YouTube. The viewer takes the role of an environmental monitor who is introduced to different stakeholders and must make decisions based on the timeline of events. Short video chapters offer different options for the viewer to follow by clicking on different buttons. In this way, the viewer can personally understand the lessons learned by the community in Chaco. The digital campaign raises awareness about the need for protection of indigenous rights, while also sharing knowledge about successful foundations for collective control, monitoring, and management of the territory.

But despite an elaborately produced and well-designed digital campaign in terms of content, the videos were only viewed about 200 times. The format and medium are not tailored to the target audience, rural Bolivians in Chaco, where internet bandwidth is limited. As an awareness campaign for the general public, the campaign had limited effect.

How can digital campaigns impact extractive governance?

Various actors in the extractives sector, be they companies, non-governmental organisations, donors, or governments, engage in digital campaigns, typically with two objectives:

Campaigns to prompt change

These are aimed at encouraging a specific action and change, be it political (a government or company) or personal (individual behaviour change). Petitioning a government to implement legislative reform around taxation is one example.

Campaigns to raise awareness

These might focus on a specific event, seeking to inform people about the occasion or development and its significance in their lives. The arrival of a new extractives company to begin exploration in a particular

area and the anticipated implications for local citizens, is one example. Targeted health and safety or disease prevention campaigns are another.

Digital campaigns deliver structured dissemination of information through their chosen channels. 'Storytelling' means that the campaign's message is delivered in the form of a personal story and seemingly authentic story, which often enjoy a warmer reception. Knowledge conveyed via stories does not necessarily feel didactic, but is more enjoyable and interesting for the audience.

Digital storytelling is not only used by civil society. Companies like Anglo American Plc have undertaken digital storytelling over multiple platforms with the concept of **modern mining** as a focal point. **Mining For Zambia** is an initiative from Zambia's private sector intended to share stories of mining's positive impact on the web and social media, and makes use of personal **storytelling**.



Opportunities and challenges for digital storytelling

Opportunities

- **Startup costs and barriers to ‘entry’ are low.** Many platforms allow users to build petitions or a campaign website with little know-how, while spending less money on developing bespoke tools. Many social media platforms and message applications such as Whatsapp and Facebook are free of charge.
- **Monitoring and evaluation are easier.** Measuring the reach and success of online campaigns in real-time is possible due to inbuilt activity tracking (such as link tracking) and analytics.
- **Targeting specific audiences is possible.** Micro-targeting has become easier with social media tools, reaching target audiences with specific content tailored to their needs and interests.
- **Historically under-represented voices can now be heard.** Sharing people’s authentic stories and voices that often remain unheard can increase the impact of awareness campaigns.

Challenges

- **Quality content costs money.** Although the dissemination of content is less expensive via digital means, the production of good content still has its price.
 - **Identifying the right medium for the right audience is key.** Campaigns have to be carried out in a medium that is accessible to the target group, for example video requires good bandwidth.
 - **Knowledge doesn’t equal behavioural change.** Raising awareness is often not enough to motivate people to take action.
 - **Data security is a concern.** Responsible use of data is important and is increasingly being legislated. If identities of campaign supporters (e.g. signing a petition) are openly displayed they need to be informed about the risks.
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4. E-learning to redress knowledge imbalances

E-learning is a vital modern tool for skills development. It is free from the constraints of traditional learning environments in that it does not require the student to be physically present in any particular country, institution or place. The flexibility of e-learning allows for learning outside of traditional work hours. A wide range of skills can be taught, from practical knowledge to more strategic skills relating to governance of the extractives sector.

What is e-learning?

E-learning is the support of learning processes through the use of information and communication technologies. In most cases, it refers to a course, programme or qualification delivered completely online.

How can e-learning impact extractive governance?

One of e-learning's key strengths is its potential reach. The assumption is that as more online trainings for different stakeholders in the extractives sector become available, more actors will be empowered to influence extractives governance positively. Education and training can demystify technical jargon and difficult concepts, broaden stakeholders' understanding of the mechanics of extractives economics and explain extractive project lifecycles. This can help rectify the knowledge asymmetry that often exists between extractives companies on the one hand, and governments and communities on the other. E-learning's potential in terms of the extractives sector touches on several areas.

- E-Learning can support educational institutions to 'upskill' their country's graduates so that they are

better placed to secure jobs in international mining or oil and gas companies. The same applies to civil servants, or managers in the private sector.

- Training workers to comply with health, safety or environmental guidelines in the extractives sector is vital. E-learning can assist smaller firms and their employees to understand the requirements of government regulations.
- Even with modest funding, civil society actors can use e-learning to build their understanding of the law, regulations and international benchmarks in the extractives sector. This can enhance their ability to monitor the practices of extractives companies operating in their country and constructively engage in policy dialogue.

Forms and modes of e-learning

E-learning can take many forms, but here are examples of how it is being used in the extractives sector:

Massive Open Online Courses (MOOCs)

In 2016, the Columbia Center on Sustainable Investment, the Natural Resource Governance Institute, and the Sustainable Development Solutions Network, with support from the World Bank, launched a free online course that allows anyone, anywhere to learn about how natural resources can be a catalyst, rather than an obstacle, to achieving the Sustainable Development Goals. These types of courses are called Massive Open Online Courses (MOOCs) – they are organised, open courses that are available via the internet. Whilst MOOCs are available for an unlimited period of time, lecture videos and supporting material are only available on so-called ‘Moodles’ (Modular Object-Oriented Dynamic Learning Environment) for a limited period. Students participating in these e-learning programmes use videos and tests as part of the learning process, and can help each other out through various forums and blogs.

Open Education Resources (OER)

Probably best known for American Ivy League universities making videos of their lectures freely available on the internet, Open Education Resources (OER) is a tool for open online education – i.e. licence-free teaching and learning materials on various subjects. Many charitable foundations and government agencies are currently working to promote the OER movement. As one example, the Hewlett Foundation has funded the Massachusetts Institute of Technology (MIT)’s Open Courseware programme which now offers over 2 000 university courses online, under free Creative Commons licences.

Blended learning

The combination of in-person and online learning offered in blended learning scenarios makes it possible to take advantage of the respective settings and methods and to avoid their disadvantages. In blended learning scenarios, three forms of activity can be distinguished or combined with each other: self-directed e-learning, live e-learning, and traditional classroom learning. The University of Dundee’s Centre for Energy, Petroleum and Mineral Law and Policy, for example, blends classroom time with webinars and other forms of digital learning in its extractives courses.

Case Study

Australia's Oothung Sisters in Mining Programme teaches truck driving through virtual simulation

The **Oothung Sisters in Mining Programme** in Australia is a collaborative initiative between mining equipment company Thies, Curragh coal mine in Western Australia, and The Salvation Army. The initiative is a pre-employment programme designed to prepare its participants for careers as haul truck operators. It is aimed primarily at Australian indigenous women who have been historically marginalised from the profession, and participants are not required to have any prior mining experience. They complete three weeks of pre-employment training at a Mobile Training Centre with a high-speed internet connection, where they are taken through a haul truck digital simulation programme. This allows them to master haul trucking skills using virtual reality, along with other important job training. Graduates of the programme can then complete a competency-based traineeship, which contributes towards a nationally recognised Certificate in Surface Mine Extraction Operations and a permanent, full-time position as a haul truck operator. Since the launch of the Sisters in Mining Programme in 2013, 32 women have graduated and successfully found work.

Opportunities and challenges for e-learning

E-learning's potential is vast and arguably under-utilised. While it is not cost free – in fact, designing quality online content can be time consuming and costly – the scale of the potential audiences e-learning can reach means the costs remain relatively low.

Quality assurance is a persistent challenge. The quality of e-learning training varies greatly: some organisations simply upload PowerPoint presentations and label that 'e-learning.' At the other end of the quality spectrum, there are cutting edge providers using sophisticated virtual or augmented reality technology in their learning resources, for example to simulate hazardous situations. Some online training initiatives use immersive simulation technologies, such as the Oothung Sisters in Mining Programme, which trains indigenous Australian women to become truck operators (see the accompanying case study on this).

There are also actors in the extractives sector that are not yet able to take advantage of e-learning. Small-scale miners are often small enterprises of less than ten people and just one or two pieces of mining equipment. They may not have access to the internet, and so are unable to benefit from e-learning courses that could assist them with growing their businesses, upgrading their mining practices, strengthening their skills sets, or communicating information on their legal and regulatory status.

Opportunities

- **E-learning is affordable.** The relatively low cost of online training courses can facilitate more equitable access to education on extractives topics.
- **It's scalable and flexible.** The potential scale of e-learning means its impact and audience reach could be significant. Online training programmes can be easily adapted to meet multiple language and knowledge-level requirements.
- **E-learning is available at all stages of one's career.** E-learning presents an opportunity for life-long learning, allowing workers to upgrade and hone their skills throughout their working life.
- **It can assist those who have not formally studied in the extractives sector.** More knowledge narrows the gap between extractives companies' capacity and that of government or communities – e-learning can assist with demystifying complex concepts or extractives-related economics through easily accessible information.
- **It can help disseminate important information.** E-learning offers governments, companies or civil society the opportunity to communicate a consistent message to large groups of users – for example on compliance with standards, or best practice.
- **It can prepare people for difficult scenarios.** Interactive formats such as simulations can enable students to feel they have experienced actual scenarios that may be encountered during mining operations, for example, or policy scenarios.

Challenges

- **E-learning requires the internet.** Limited or no access to the internet, and low information and communication technologies (ICT) literacy remain significant obstacles for many actors in emerging economies wanting to access e-learning.
 - **Effective e-learning requires a certain level of education.** Low levels of education or literacy can hamper learning competencies – many e-learning students fail due to a lack of learning skills.
 - **It is still overwhelmingly in English.** Other languages and dialects are still to be incorporated in e-learning platforms.
 - **Quality is variable.** Trainers can claim that any online course, regardless of the quality, is 'e-learning'.
 - **The certification of qualifications is generally under regulated.** There is no reliable way of verifying identities for online examinations and there are no internationally valid e-learning certificates as yet.
 - **Data protection remains a vulnerability.** The participating student could have his or her data shared with unscrupulous interested parties, without their knowledge or consent.
-

5. Gamification to drive engagement

Did you know that the gaming company Blizzard reported over 37 million active users across its suite of games such as *World of Warcraft* in the month of August 2018? This is just one example of how online games have become a central feature in the modern world. But games can be more than just entertaining – gamification means incorporating elements of gaming into areas that normally might have nothing to do with play. Gamification is increasingly being introduced into the world of business and government, because it is believed to improve users' retention of information and can generate creative solutions to problems. Although gamification is closely linked to the concept of e-learning, there are differences which merit discussion.

What is 'gamification'?

Gamification is the introduction of game mechanics into an online platform, activity or community in order to motivate participation and engagement by users, or to solve particular problems. Game mechanics could include scoring points or competing with other players, while adhering to specific rules of play.

How can gamification impact extractive governance?

The extractives sector is highly technical and its timeframes are long. The time from exploration to closure sometimes spans many decades. These complexities are often barriers for governments, regulators, communities or citizens wishing to get involved in the governance of their country's natural resources.

Gamification provides a potential tool to encourage greater engagement by stakeholders regarding the impacts and opportunities presented by the sector. Games in the form of simulation and role-play, for

example, can be used in scenario development for policy making around extractives (see the Petronia Games case study). Safety training for mineworkers can also utilise game mechanics to encourage greater engagement and retention of important information. Such games help to more closely link cause and effect in the world of extractives governance, by speeding up scenarios, which might play out over years and decades, into a matter of hours. This can sharpen understanding of the importance of extractives governance and good decision-making.

Case Study

Welthungerhilfe: simulating land speculation through gamification

The German civil society organisation Welthungerhilfe created a satirical online game to highlight the issue of large-scale land acquisition by foreign investors. In the game, called **'Das kostet die welt!'** ("How much does the world cost?"), the player adopts the role of a predatory investor, putting whole countries into an online shopping cart. The player is incentivized to behave as a profit-hungry speculator and grab land that is arable, well irrigated, and vulnerable to corruption. A land grab in the Democratic Republic of Congo really pays off in the game – it's worth 2 000 points. When the player's shopping cart is full, the points are tallied up and the player is ranked on a scale from petty criminal to global player.



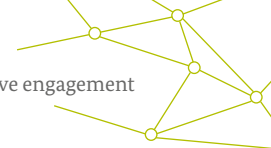
For a world without hunger

Initially players just try to get a high score, but in the process, they learn about the real-life consequence of land grabs: the intensive water consumption, the sinking water table, and the destitution of smallholder farmers driven from their land. For players who want to help change this, there's an option to donate to Welthungerhilfe in proportion to how many points they scored – the more successful the land grab, the higher the donation.

Case Study

Petronia Games

The Natural Resource Governance Institute (NRGI) launched **'Petronia Games'** in June 2018. This original online simulation game has received critical acclaim and a positive reception from stakeholders in the extractives governance space. The game takes place in the fictional country of Petronia where a large oil discovery is about to be developed, with potentially life-changing consequences for its citizens. The player must fly to Petronia to advise the President on how best to construct policies to unlock the oil's potential for the development of the country and its people. With a visually engaging interface and clever use of sound, Petronia Games is an entertaining and interactive game. Players are required to listen to experts, consult stakeholders, analyse data, and make recommendations. According to the NRGI, the full learning experience takes four to eight hours (or one to two hours per mission) and is suitable for users who may not have the time to complete the NRGI's MOOC or in-person courses on offer.



Opportunities and challenges for gamification

There is evidence that the connection between gaming and the extractives sector is being actively explored. A single search in Google's Play Store results in more than 20 games dealing with extractives governance related topics. The target audience for these games appears to be primarily experts from the sector, technical staff, government officials or civil servants from resource rich countries, and students who want to improve their understanding of extractives governance through scenario simulation. There currently appear to be no games designed for small-scale miners, and local civil society organisations in local communi-

ties do not seem to be using gamification as a technique, possibly because of the skills required.

Caution in estimating gamification's ability to effect meaningful change is recommended. Research into the causal connections between playing games and behavioural change and learning is still in its early stages. We do know that whilst playing games, more and different parts of the brain are activated than during passive learning. Under what circumstances sustainable changes take effect is the subject of ongoing debate.

Opportunities

- **Gamification can encourage deep engagement with a situation or problem.** As drivers of learning, so called 'serious games' can immerse users, create suspense, and encourage competition, while imparting skills at the same time.
- **Games can reach young people.** Gamification clearly holds appeal for younger, technologically-savvy citizens. This is particularly important as young people are the most impacted by the long-term consequences of extractives activities. Effective promotion through local partners and the media, and engaging sub-groups of players who are highly networked and targeted timeously, can raise a game's profile.

Challenges

- **Game development is expensive.** Particularly when it comes to a complex and specialised sector like the extractives, expert input is critical but an expensive component.
 - **Success can be difficult to predict.** Whether a game will successfully engage its target audience is often uncertain until it is launched. One mitigation strategy could be to design games as just one part of a larger project, and involve partners from the beginning.
 - **The price tag can raise expectations about impact.** Successful games, which can cost up to millions of dollars to develop, can raise expectations from users about their effectiveness and impact, which the games may not deliver.
 - **Educational games risk being didactic.** The 'fun' principle of gamification is compromised when players are made aware that knowledge transfer is taking place.
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6. Blockchain's potential to build trust

The role of Blockchain

A blockchain is a particular type of distributed ledger technology (DLT) in which multiple transactions are grouped together into a 'block' for batch processing by all computers on the network. Each block is subsequently joined to previous blocks in a chain cryptographically and chronologically: hence, 'blockchain'.

The blocks in the blockchain cannot be changed or deleted by a single actor; instead, they are verified and managed using automation and shared governance protocols. This design renders fraud virtually impossible – although it cannot prevent theft, which is a separate issue.

How can Blockchain impact extractives governance?

The gap between theory and reality when it comes to Blockchain's potential impact is considerable at present.

While the enthusiasm for Blockchain potential is evident in a great many sectors, actual experiments with the deployment of blockchains in the extractives sector are in the early stages. A forthcoming report from the Natural Resources Governance Institute (NRGI) on the practice and promise of blockchain technologies for extractives governance examines this topic in detail. The report cautions against proposing Blockchain as a blanket solution to all problems faced in the extractives sector and notes that meaningful impact

evaluation is still lacking. NRGI elaborates governance implications of DLT application in the fields of commodity trading, land registries, supply chain tracking and corporate registries.

Nevertheless, a number of initiatives are under way to test new applications for this technology in both mining and oil and gas. Blockchain's potential to assist with responsible mineral sourcing, by allowing miners to demonstrate their commodity's chain of custody at every stage, is being explored by several actors. Some of the potential areas for innovation using DLTs are noted below.



Case Study

Everledger: tracing diamonds using Blockchain

London-based technology company Everledger is using blockchain technology to build a shared digital ledger in order to track diamonds from mine to market. The aim is to eliminate so called 'blood' diamonds from international markets and to ensure compliance with the Kimberley Process. The company records 40 metadata points to create a unique 'fingerprint' of each diamond and translates this information, in addition to all information on where and when it was mined, into Blockchain. Around 1.6 million diamonds are currently captured in Everledger's Blockchain. The processing chain contains not only information about the origin of the diamond, but also its custody right until it is sold – from the person who has chosen the rough, the person who designed its cut, the person who actually cut it, and the person who grades it. You can view a simulation of the process in Botswana [here](#).

Case Study

The Georgian government is recording land titles on the blockchain

In the Republic of Georgia, the National Agency of Public Registry (NAPR) has initiated a project to capture and record land titles on the blockchain with Bitfury, a blockchain technology company. By using Bitfury's open-source blockchain framework Exonum, NAPR can provide citizens with a digital certificate of their assets, supported by cryptographic proofs published on the blockchain. The main goal of the project is to develop a solution to provide citizens and governments with data security, auditable processes, and transparency. The project aims to reduce the registration and verification process time from three days to just a few seconds – which is up to 400 times faster than the original length of time. Since launching in February 2017, the project has successfully timestamped more than 1.5 million documents to the public Bitcoin Blockchain. Other Blockchain-based pilots for maintaining land registries are under way in Sweden, Honduras, and Brazil. View their online case study [here](#).

Opportunities and challenges in using Blockchain and DLTs

The success of many Distributed Ledger Technologies remains untested. Early pilot applications, which could strengthen extractives governance, are underway, but to date there is still little proof that they work. And while DLTs and Blockchain might provide more efficient and transparent digital infrastructure, they are unlikely to alter any underlying power dynamics at play in the sector. Blockchain transactions are unable to resolve complex political and economic problems.

In addition, many legal and regulatory issues around DLTs remain unresolved, and the necessary network infrastructure to make many applications feasible in the near future is not in place. Currently, the Linux Foundation is supporting the **Hyperledger** project, an open source collaborative effort to advance cross-industry blockchain technologies and standards. The aim is to create an open, standardised, and enterprise-grade distributed ledger framework and codebase.

Opportunities

- **DLTs have the potential to reduce information asymmetries and increase transparency in the extractives sector.**
- **DLTs can reduce waiting times.** The technology can contribute to efficiency gains in administrative bodies, by automating and thus reducing the time required for verification processes.
- **DLTs can make tax avoidance or evasion more difficult.** Innovative new forms of taxation and fiscal management may arise through the use of Blockchain and DLTs. For example, by automating the taxation of revenues directly in a distributed ledger, tax avoidance could become more difficult for companies, and civil society could have more insight into the revenues governments are receiving.

Challenges

- **DLTs can exacerbate information asymmetries and reduce transparency if improved governance is not a motivating driver behind a DLT initiative.**
 - **DLTs can be very energy intensive and these have emissions implications.** Running large or complex DLTs can also have climate change implications due to their sometimes extraordinarily high power demands.
 - **DLTs rely on consistent and high quality internet access.** Without these fundamentals, the application of these technologies in resource-rich countries might continue to be modest.
 - **The ‘garbage in, garbage out’ challenge.** Data quality at the point where the distributed ledger or Blockchain starts remains a challenge. All data entering a blockchain must be checked for accuracy – this might involve manual processes by third parties, which is costly and might be prone to error and fraud.
 - **Transitioning to DLTs is expensive.** Digitising administrative processes requires huge upfront costs, similar to digitising libraries. Furthermore, usage and maintenance also add substantial additional costs.
 - **Certain processes are highly complex.** The complexity in tracking commodities varies greatly. Tracking the chain of custody for a mineral such as cobalt, for example, is far more complex than diamonds, typically involving 12 steps as opposed to just five stages for gems.
-

7. The Internet of (extractives) Things

Although the Internet of Things (IoT) has only entered popular consciousness in recent years, it has been around for decades. In 1990, the first internet-connected toaster was unveiled at an early stage internet conference. Any sector that uses technology will be impacted by the increasing connectivity and digital intelligence of the Internet of Things. The extractives sector, with its dependence on specialised machinery and equipment, will be no exception.

One of the key areas of responsibility for any government seeking good governance of its extractives sector is upholding good health, safety and environmental (HSE) practices. A history of employee deaths, unsafe work places (particularly with deep level mining or remote oil rigs) and environmental disasters has contributed to mistrust of the extractives sector, which in turn can negatively impact local policy and governance. Technological advances and improvements in productivity, safety and monitoring of extractives companies' performance are potential areas where the IoT can enhance governance.

The trend of devices sharing data and experiences with each other in an extractives context is set to increase in the coming years. Two factors are contributing to this. Firstly, the plummeting cost of these technologies is likely to drive more innovation and development. According to 2016 data from Goldman Sachs the cost of IoT sensors is set to drop by 70% from 2014 to 2019.

What is the Internet of Things?

The Internet of Things (IoT) is the network of physical devices, including machines, equipment, vehicles, home appliances, and other items embedded with electronics, software, sensors, actuators, and connectivity which enables these things to connect, collect and exchange data. This interconnectedness adds a level of digital intelligence to devices.

Secondly, the sensor technology that underpins the IoT is rapidly becoming more sophisticated. Basic tags called radio-frequency identification (RFID) tags can be attached to almost any device now. Sophisticated multi-sensors that transmit data about location, performance and environment are also becoming more common. It is becoming possible to place sensors in any object (and even in human beings) and track metrics such as location, temperature and movement patterns, using technologies such as micro-electromechanical systems (MEMS).

RFID sensors as a basis of the Internet of Things

Radio-frequency identification (RFID) technology is widely deployed in various industries worldwide, for a variety of applications including retail and supply chain, healthcare, transportation and logistics, and mobile applications. An RFID system typically consists of a reader or 'interrogator', and a tag or 'transponder', which is attached to the item to be identified. The in-

terrogator reads the tag and receives identification data back from the tag. Unlike a barcode, the RFID tag does not have to be scanned directly, and does not require a line of sight to a reader. There exists an international transmission standard known as Near Field Communication (NFC) that uses RFID technology for the contactless exchange of data.

How can RFID tags impact extractive governance?

In today's extractives sector, sensors are used in a variety of applications in extractives activities, mainly by large-scale companies. These focus primarily on health, safety and environment applications. Examples include:

- Sensors in mineworkers' helmet headbands to detect fatigue
- Air quality sensors in residents' homes can monitor and record evidence of pollution in natural gas infrastructure
- Sensors to monitor mineworkers movements underground, or in potentially dangerous environment conditions

- Sensor-controlled machines that enable autonomous mining

Governments and small-scale miners have been slower to implement the technology. However, for these actors, the IoT application for monitoring a commodity's chain of custody has particularly promising governance potential, in addition to environmental considerations. Incorporating IoT features in the traditional 'bag and tag' system that forms an integral part of traceability and due diligence programmes for small-scale miners, can further help to trace the chain of custody for so-called 'conflict' minerals. This can help to ensure corrupt actors are excluded from the chain of custody, and end users have reassurance about the mineral's provenance.

Case Study

Tracking gold through its chain of custody using tags

The German company SERCAM has applied its tracking technology to trace certified and Fair Trade Gold trading chains, including gold being mined by small-scale cooperatives. Their Global Object Tracking System project equips mineral transport bags with an electronic seal using RFID. The seal records all transaction data for each step of the process, as well as having a unique serial number that is physically printed on the bag. The corresponding mobile app reads exactly when and where a transaction has taken place, using the data transmitted from the transport seals. Representatives of authorised gold extraction cooperatives and mine representatives can access and export statistics regarding their own cooperative/mine. The technology does not require a permanent online connection-areas without network coverage can still be included thanks to in-device data caching.



Opportunities and challenges for the Internet of Things

Opportunities

- **The IoT generates data for greater insights.** Smart utilisation of data generated by the IoT in the extractives industry can strengthen policy and regulation of the sector.
- **It can protect people and the environment.** For health, safety and environment applications, the IoT offers real-time information, which means rapid response and intervention becomes easier and more precise.

Challenges

- **The IoT generates data, but accessing that data can be challenging.** In the extractives sector, the owner of devices connected to the IoT tends to have control over the data it generates. The data is not necessarily available for learning, compliance and governance purposes.
 - **The IoT poses a unique security threat.** As cyber theft and cyber warfare become more common, security experts are concerned that the interconnectivity of devices and equipment opens up weak links in cyber security, which could make extractives companies and governments more susceptible to security attacks.
-



8. Recommendations

Here are some recommendations on how actors in the extractives sector, no matter what their role, can ex-

plore opportunities to improve transparency and strengthen governance through digital tools.

Governments should invest in digital innovations that improve extractive governance

Digital innovations hold the potential to improve extractive governance, and to make it easier and cheaper. Allocating the required human and financial resources to understanding the role technology could play in their country's extractives sector governance is a vital

investment every government should consider making. Collaborations with technology innovation 'ecosystems' can be powerful although the long term cost implications should always be considered carefully.

Consider the Principles for Digital Development when designing tools

Too often, digital tools are launched and promptly fail, as discussed in this report. Considering the nine **principles for digital development** can help pre-empt some of the most common pitfalls. The digital principles include:



Design with the user in mind



Understand the existing ecosystem



Design for scale



Build for sustainability



Be data driven



Use open standards, open source, open data and open innovation



Re-use and improve



Address privacy and security



Be collaborative



Digital innovation requires internet access

A reliable internet connection with reasonably fast speeds is a prerequisite not only for most tools explored in this report, but for the necessary ICT literacy to develop. Only with these two building blocks in

place can digital experimentation and innovation begin to flourish. By broadening the reach and quality of internet access, extractives communities will be better placed to play more active roles in governance.

More initiatives in local languages are needed

The overwhelming dominance of English on the internet means digital tools in local languages are few and far between. Yet there is evidence that engagement in users' mother tongue is by far the most effective for

retention of information and skills. There is significant opportunity for more digital projects outside of English, particularly when it comes to local communities impacted by the extractives sector.

Develop common DLTs standards

Few digital innovations have attracted as much enthusiasm as Blockchain and Distributed Ledger Technologies (DLT). Principles to guide design and implementation, and standards to govern this new technology will be critical in determining their governance implications. The development of common standards must be

a multi-stakeholder effort, however, to avoid them being unilaterally defined by for-profit actors. Governments, civil society organisations and communities should add their voice to the process of defining common DLT standards where they impact extractive governance.

9. Authors and acknowledgements

Authors

Franziska Kreische studied peace and conflict, and she is interested in how digital technologies can support peace processes. After her Masters degree, she lived in Uganda for a period where she worked on development projects. As a researcher at **the betterplace lab**, she specialises in women in technology, and studies, researches and writes about this topic.

Kathleen Ziemann is a trend researcher at the betterplace lab. She worked in the public relations department of Médecins Sans Frontières (MSF) International previously. She joined **the betterplace lab** in 2012 and she is responsible for producing reports in the area of Information and Communications Technology for Development (ICT4D). She was an editor and project manager on betterplace lab's annual publication **Trend Radar 2030**, produced in cooperation with BMZ.

Stephan Peters studied linguistics and communications. Previously he worked as a copywriter, and later at the Freie Universität Berlin in the *Languages of Emotion* Cluster of Excellence as a research assistant. He was also employed as a lecturer at the Technische Universität Berlin. In 2013, he came to the website thebetterplace.org to build the marketing function, and he moved over to **the betterplace lab** in 2015 where he is researching the effects of digitisation on Germany's social sector.

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Project 'Sector Program Extractives for Development'

Friedrich-Ebert-Allee 36 + 40
53113 Bonn, Germany
T +49 228 4460-0
F +49 228 4460-17 66

Dag-Hammarskjöld-Weg 1 – 5
65760 Eschborn
T +49 6196 79-0
F +49 6196 79-11 15

E info@giz.de
I www.giz.de

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Text
Franziska Kreische, Kathleen Ziemann, Stephan Peters

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