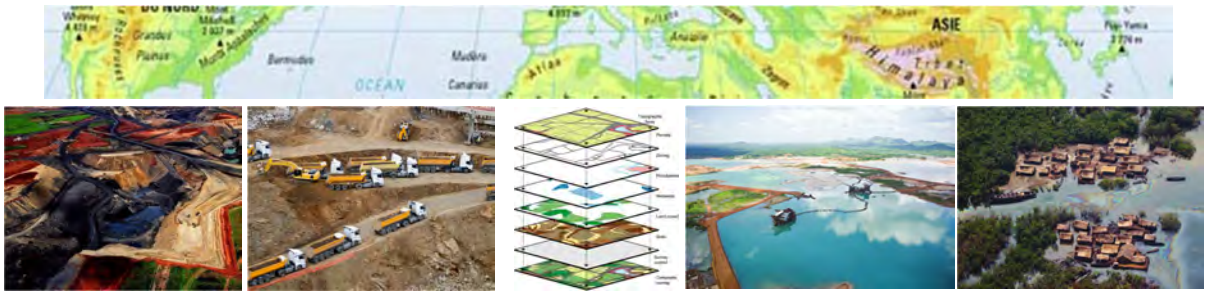
UNIVERSITÉ DE GENÈVE

INSTITUT DES SCIENCES DE L'ENVIRONNEMENT

CERTIFICAT COMPLEMENTAIRE EN GEOMATIQUE



IMPROVING THE MEASUREMENT OF GOVERNANCE IN THE EXTRACTIVE INDUSTRY USING GIS

Mémoire présenté par

Marinkovic Robert

Sous la direction du Dr. Pierre Lacroix

enviroSPACE lab., Institute for Environmental Sciences

University of Geneva

SUMMARY

Transparency has emerged as a cross-cutting cure to the resource curse and is hailed as a tool to reduce corruption, improve governance, increase legitimacy and accountability, and empower stakeholders. The proliferation of international transparency initiatives and governance measures attests to the global traction this policy domain has gained but it has also sparked research into the efficiency of transparency measures. The Resource Governance Index (RGI) is a relatively recent transparency policy index; it quantifies governance and transparency in the extractive industry sector through a composite score attributed to each country. Considering the temporal and spatial complexity of the concepts it attempts to measure, is a tool like the RGI methodologically adequate and does it provide an efficient evaluation? After a literature review of governance, transparency, and the resource curse within the context of the extractive industry a critical analysis of the methodology of the RGI is provided followed by recommendations for an improved index. Considering the dynamics of the extractive industry, this paper argues that the RGI could benefit from implementing a spatial component and mapping relevant data in order to cut across scales and highlight the spatial mechanisms in resource governance. GIS tools are being used more and more widely and the extractive industry is no different. However, rather than a consistent concerted global effort, use of GIS is still restricted to case studies and pilot projects. Recognizing that the implementation of GIS into the RGI would be a considerable task this work aims to open up the debate by presenting arguments for the use of GIS and on how this could be achieved. This paper then asks the question of how GIS and mapping could be used to better measure resource governance and improve the scope of the RGI?

Contents

1. INTRODUCTION

1.1 Extractive industries and governance

The use of natural resources, renewable and finite, for the development of human society is as old as human society itself. With industrialization and modern technology, the extraction of these resources has seen an impressive growth. "While a human in a hunter-gatherer society required around 3 kilograms of biotic and abiotic material in a day, the consumption of a present-day human in an industrial country lies at more than 40 kilograms per day". (Swiss Academies of Arts and Sciences 2012) With this rise in consumption there is also an increased consciousness of the finite nature of some of these resources. While metals, minerals, and oil in particular can create great riches for those that possess and exploit them there has also been a rising awareness of the multitude of problems they can create if used without care. "Society's expectations of the sector's [mining and metals] performance are high and continue to increase. This manifests itself in pressures for higher standards of social and environmental performance, greater transparency, and more participation in decision-making by stakeholders that have historically played only a marginal role." (ICMM 2012) The question is therefore how to use these resources for the benefit of humanity while limiting or even negating the already recognized negative effects of the extractive industries? The growing consumption of resources coupled with the growth of the human population in parallel increases the pressures on the Earth ecosystem as well as socio-economic pressures in society. Good management of these resources is therefore becoming more important than ever and at all scales: local, regional, national, and global (Ostendorf 2011). Good management assumes knowledge of the process that is being managed. "Science can play an important role by making the effects of the use of natural resources measurable and therefore comprehensible and by interpreting the results of application of these indicators." (Swiss Academies of Arts and Sciences 2012) The keyword here is measurement; in order to have evidence-based governance and management of natural resource extraction measurement of all the processes, conditions, and effects of this industry is vital.

The International Council on Mining and Metals (ICMM) believes that through "responsible public and private management, the mining and metals industry can contribute to poverty alleviation across the world while maintaining ecosystem integrity" (ICMM 2012). While this may seem as a lofty goal or a case of having the cake and eating it too, it is at least an ideal worth tending to. This work will take a look at theoretical and methodological considerations aimed at helping the extractive industries reach this goal. By looking – among others – at the relatively recent Resource Governance Index (RGI) produced by the Natural Resource Governance Institute (NRGI) as an example of a concrete measure of governance in the extractive industries this work will propose an improved measurement of resource governance based on evidence stemming from the relevant literature.

1.2 Research questions and structure

In particular, one can argue that a spatial component could greatly improve the pertinence and insight the RGI gives to its users. Geographic information systems (GIS) have come a great way in recent years and the proliferation of its use in a multitude of domains attests to the potential this technology has to improve analysis of human and natural systems. The extractive industries and the governance of natural resources are a prime candidate for GIS analysis considering the crucial spatial component of these activities. While case studies of specific countries and projects abound in the literature and composite indexes measuring transparency, corruption, or sustainability with a purely numerical score have become more and more popular there is no systematic approach as of yet that integrates all components into a consistent single measure. The main question guiding this work is therefore: ***How can a geospatial component support the analysis of the RGI?*** Stemming from this main question are two working hypotheses that will guide the literature review, discussion, and final recommendations:

- It is necessary to combine several other components with the RGI to produce a more holistic and efficient measure of the governance of natural resources.
- There are existing complementary approaches that can be used in combination with the RGI.

Further sub questions are:

- What are the current gaps and weaknesses of the RGI?
- What are the preconditions or barriers to producing a geospatial component of the RGI?
- What is the appropriate temporal and spatial scale when analyzing natural resource governance?

This work will be structured as follows: a brief methodology section followed by a literature review of the crucial theoretical concepts such as the resource curse, governance, and transparency will place this work in its context and review what are the major currents of thought and problems in this domain, the second part consists of a breakdown of the methodology of the RGI in order to identify gaps and areas of improvement, the third part will present considerations and relevant literature that need to be taken into account when incorporating a spatial component, the fourth part will present an ideal improved measure that builds on the methodology for calculating the RGI and combines other components to create a more efficient indicator, and finally the conclusion will summarize the key messages and findings.

1.3 Methodology

This paper is part of the work accomplished for the Complementary Certificate in GIS of Geneva University and is the final step required for the validation of the Certificate. It was written under the guidance of Dr. Pierre Lacroix who is a member of the enviroSPACE lab.

Considering this work had to be done in a two month period, certain aspects were reduced and not analyzed fully in order to stay in line with that deadline. The structure and methodology employed correspond to a literature review report. A read-through of the RGI report and methodology, information available on the website, intent, goals and objectives was undertaken as a first step in order to determine the context of the study. This was followed by a wide scope exploration of all possible sources of relevant literature and information coming from academic sources, NGOs, governments, international press, and stakeholder associations. This step allowed to fine-tune the scope of the study and pinpoint sources on a scale from least to most relevant/specific. This exploratory phase also allowed the identification of specific articles and reports that provided the basis for further reading in a branching out process. Finally the assembled literature was grouped into categories corresponding to different concepts analyzed. On the one hand literature relevant to the theoretical framework of concepts like transparency, governance, and corruption in the extractive industry was sought out and on the other hand literature detailing practical applications of these concepts through instruments like transparency initiatives and indexes was also searched for. GIS tools and practical applications within the context of the extractive industry was the final category of literature analyzed. In light of the literature the RGI methodology was critically analyzed in order to identify gaps, possible improvements, and barriers to improvement. This step was therefore followed by a critical appreciation of the RGI, the development of recommendations based on the literature, and a consideration of possible ways in which a spatial, GIS component could benefit the evaluation of resource governance. Finally, a tentative implementation of a GIS component into the existing RGI structure is proposed as the result of the literature review. This final part presents conclusions and recommendations based on the literature review and shows the different possibilities that further research could explore. Even though many of these aspects merit a more detailed analysis they were not treated in their full extent due to the time constraint of this work.

2. LITERATURE REVIEW

2.1 Resource curse

The concept of a resource curse grew out of economics following observations that countries with abundant natural resources did not develop economically and socially at an expected rate. In other words, growth in resource abundant countries was similar or even lower than in countries with no abundance of natural resources. Sachs and Warner (1995) were among the first, following an influential report funded by the World Bank in 1988 and a seminal book by Richard Auty in 1993 (Gilberthorpe and Papyrakis 2015), to demonstrate a lower growth in resource rich countries and identified the Dutch disease[1] as the main mechanism responsible for this dynamic. However, the observed effect was not present in all resource rich countries and some struggled with the curse much more than others, which

[1] A precursor to the resource curse concept, the Dutch disease concept is based on the Dutch experience of one economic sector developing at the detriment of others after the discovery of a large gas field (a rise in export rents causes an appreciation of the domestic currency that makes the non-resource sectors less competitive, undermines growth, and puts inflationary pressures on the economy (Mejía Acosta 2010)).

lead to the question of how exactly would the mechanism of the resource curse work. Corrigan (2014) presents a summary of the historical and methodological development of the resource curse research and analyzes some very important measurement questions (looking at resource intensity versus gross production versus per capita output for example). Shaxson (2007) provides some of the earliest examples (Equatorial Guinea, Angola, and Nigeria) that spurred the debate and confirmed the existence of a resource curse in some countries. Mejía Acosta (2010) provides a brief overview of the main findings and arguments in this domain. It is not within the scope of this work to discuss all the details and intricacies of the resource curse but rather to use it as a starting point in order to understand why resource governance is important.

What started as a purely economic analysis looking at a possible causal link between resource abundance and GDP growth soon branched out into many other domains and researchers started looking at other factors that could be linked and affected by a large extractive industry sector. Corrigan (2014) traces the evolution of research on the resource curse from a focus on economic variables and effects to a broader scope looking at institutional quality, corruption, conflicts, and governance. Inspired by countries like Norway and Botswana, some authors (Mehlum et al. 2006, Sala-i-Martin and Subramanian 2003) found another variable that influences the effects of resource abundance: "They find that natural resource abundance has a negative effect on institutional quality and that institutional quality has an impact on growth" (Corrigan 2014). It follows that there are two main factors that determine the economic impact (we will later look at environmental impacts as well) of the resource curse: the abundance of natural resources in a country and the quality of its institutions. Furthermore, considering that "a country has little control over the quantity of resources within its borders, the quality of institutions is, therefore, the most critical determinant of outcomes" (Corrigan 2014). This realization turned into a proliferation of research on governance, transparency, and corruption as related to resource abundance because these variables seemed to directly impact or be impacted by resource abundance. Shaxson (2007) provides a good overview of some of the seminal works from the 1990s research into governance and corruption and Corrigan (2014) documents studies that found tangible negative effects of resource abundance on democracy, institutions, conflict prevention, and corruption. Others also talk about the resource curse as a prelude to their research into some of the other concepts (Kolstad and Soreide 2009, Kolstad and Wiig 2009, Cust and Poelhekke 2015, Kaufmann 2015).

It is worth pointing out that some researchers highlight the link between resource abundance, corruption and state failure but also argue that the negative consequences of the resource curse are not predetermined and some countries have avoided them (Kaufmann 2015, Barrett et al. 2005). Some more recent works, including arguments against criticisms, on the resource curse and how it affects governance include Büsse and Groning (2011) and Kolstad and Soreide (2009). Frankel (2010) explores the concept and the different literature strands as well as possible causal mechanisms in depth. For a more recent

review of resource curse literature across different disciplines and scales consult Gilberthorpe and Papyrakis (2015).

2.2 Governance

Governance has therefore been identified as a very important variable when talking about how nations use their natural resource riches since it was shown that weak institutions and state failure can lead to negative consequences when linked with resource abundance. What is governance then? One important distinction is the difference between resource governance and resource management. The concept of resource management and the closely linked concept of integrated or sustainable resource management are precursors to the resource governance concept. According to C. Pahl-Wostl (2009):

"Resources management refers to the activities of analyzing and monitoring, developing and implementing measures to keep the state of a resource within desirable bounds. The notion of resource governance takes into account the different actors and networks that help formulate and implement environmental policy and/or policy instruments."

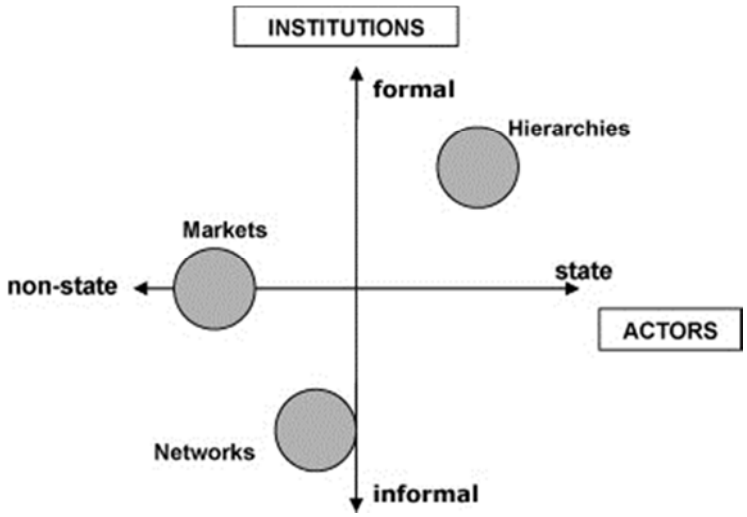


Figure 1 Difference of governance modes of bureaucratic hierarchies, markets, and networks regarding the degree of formality of institutions and the importance of state and non-state actors (Pahl-Wostl 2009)

We can see therefore that governance is more about the dynamics, interactions and power relations between stakeholders and resource users and less about the static measuring of resource use. Figure 1 illustrates different modes of governance within the context of actors and institutions. The evolution from management to governance analysis implies a change in thinking about policy processes towards a more fragmented framework where non-state and private actors carry as much influence as state actors in the formulation and implementation of public policy (Pahl-Wostl 2009). We find many strands of governance research in literature with each strand taking a different approach to conceptualizing governance. Treib et al. (2005) analyze the major streams and classify them according to their focus on politics, polity or policy and provide an excellent reference on governance. Pahl-Wostl (2009) analyzes the concept from different theoretical approaches and proposes a framework for the adaptive capacity and

learning in different governance regimes. Moreno-Pires and Fidélis (2012) also briefly touch upon governance literature in their analysis of sustainable governance and provide examples of the diversity of definitions and approaches to the concept. They conclude, however, that all the approaches share a focus on institutional analysis, that is, the "the study of how people collectively behave and construct institutions, how institutions function in practice, and why institutions persist over time" (Moreno-Pires and Fidélis 2012) and that this type of analysis is central to the concept. Hezri and Dovers (2006) provide a look at governance through the lens of ecological economics and focus on aspects of efficiency and democracy.

The World Bank has been trying to measure governance across countries for some time with its World Governance Indicators (WGI) project lead by Dr. Kaufmann. Kaufmann et al. (2011) define governance in their paper on the methodology of the WGI as: "the traditions and institutions by which authority in a country is exercised". According to Corrigan (2014) this definition points to three factors: the capacity of the government to formulate and implement sound policies, the process by which governments are selected, monitored and replaced, and the respect of citizens and the state for the institutions that govern economic and social interactions among them. For a further discussion of these indicators and the governance components they try to measure see C. Corrigan (2014). Kaufmann et al. (2011) confirm the lack of consensus and of a universal definition but they go on to break down the three factors mentioned above into operational dimensions that they further develop into indicators.

Three main mechanisms by which resource abundance influences governance negatively have been identified in the literature (Pahl-Wostl 2009, Corrigan 2014, Kolstad and Soreide 2009, Kolstad and Wiig 2009) and reviewed by Busse and Gröning (2013) while providing examples of empirical studies on these mechanisms (however, they only focus on political outcomes of resource abundance and ignore other aspects that are analyzed, for example, by Frankel (2010). First of all, so-called rentier effects have been identified by Ross (2001) in countries where natural resources provide considerable direct revenues to the state. These revenues can then create adverse effects in three forms: (1) reduce the need for taxation of the population and therefore reduce the call for accountability from the low-taxed population (taxation effect); (2) so-called patronage which is the use of resource revenues to mitigate dissent among the population and fortify one's own political support and network (spending effect); and (3) spending resource funds to prevent the formation of special interest or social groups that would advocate more political rights (group formation effect) (Busse and Gröning 2013). The second main mechanism is a repression dynamic based on the assumption that governments can use resource revenues to "suppress demands for changes in the political system or the functioning of the government in general. With greater spending on national security, resource-rich governments could impede aspirations among the population for more democracy or better institutions and government services" (Busse and Gröning 2013). The third mechanism is linked to the resource industry sector itself and follows an assumption that resource rents might prevent the modernization of the sector and induce stagnation and a status quo. The

possibility of lower education investment is also mentioned which would then impact the demand for political reform. "To sum up, due to a variety of causal mechanisms the institutional setting and quality of governance may be lesser in resource-abundant countries in comparison to resource-poor countries." (Busse and Gröning 2013)

One of the main effects of resource abundance, therefore, is increased corruption in the political sector which plagues the governance regime and lowers institutional quality. Kolstad and Soreide (2009) affirm boldly: "Corruption is the main reason why resource-rich countries perform badly in economic terms. This is an implication of current theories and evidence on the resource curse. This suggests that corruption is the development problem in resource-rich countries rather than just one of a number of problems." In parallel, transparency has risen as corruption's nemesis and the concept has gained much traction in recent years as the perfect weapon for combatting corruption and therefore improving governance in resource-rich countries. We will analyze these two interlinked concepts in the next section. Transparency has therefore been identified as a sort of proxy variable of good governance.

2.3 Transparency and corruption

"Secrecy serves to entrench incumbents, discourage public participation in democratic processes, and undermines the ability of the press to provide an effective check against the abuses of government." (Stiglitz 1999) This quote illustrates the link between transparency and corruption and fits into the context of the research outlined above. Figure 2 provides an illustration of the correlation between political transparency and the control of corruption. As we can see there is a positive trend between higher transparency and higher control of corruption.

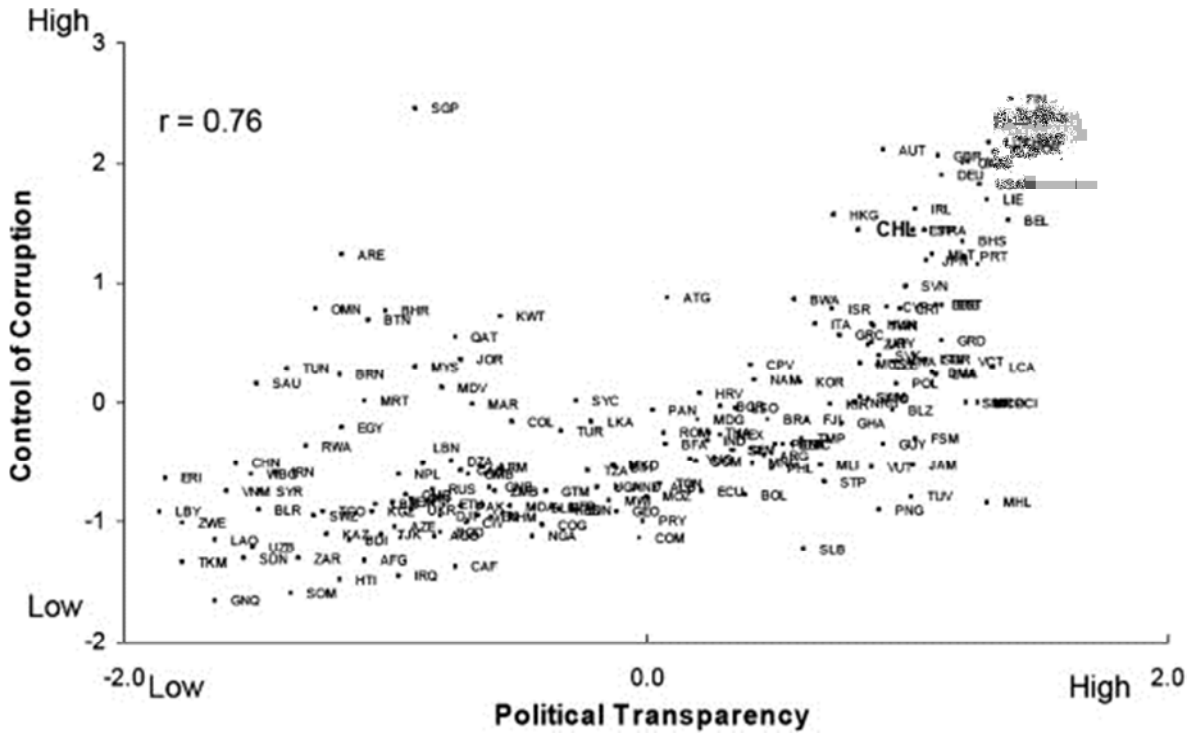


Figure 2 Political transparency and corruption (Kaufmann and Bellver 2005)

It is beyond the scope of this work to delve into all the details and nuances of the corruption concept so, while providing relevant literature and a brief overview, the focus will be rather on transparency and the different dimensions thereof all the while taking into account relevant links with corruption. For a detailed look at the linkages between corruption and transparency consult Kolstad and Wiig (2009). For a broader look at transparency within the context of environmental governance consult Gupta and Mason (2014).

This section will, however, explore questions of what exactly is transparency, what kind of impacts it can have in the context of resource governance and how it can be used in the most efficient manner to underpin good resource governance. So what does transparency consist of and how does it fit into the resource curse and resource governance agenda?

As stated by Kaufmann (2015) of the NRGI writing about and measuring corruption have become less of a taboo topic in recent years and researchers have started tackling the problem along with NGOs and governmental initiatives. Within this scope, transparency has surfaced as an almost universally accepted means to curbing corruption (Bleischwitz 2014, Mejia Acosta 2010, Haufler 2010, Kolstad and Wiig 2009, Michener 2015, Corrigan 2014, McHenry et al. 2015, Alstine 2014). "In addressing corruption – and more generally enhancing accountability and governance – in natural resources, one should not underestimate the importance of transparency." (Kaufmann p15, 2015)

Transparency can be defined as the disclosure (providing public access to) of reliable economic, social and political information, that governments and/or corporations previously considered confidential, in a timely manner and making it accessible to all relevant stakeholders (Bleischwitz 2014, Kolstad and Wiig 2009). This concept and its supposed positive effects on curbing corruption and improving governance has spurred a proliferation of a number of transparency initiatives that try to implement transparency in governmental and corporate processes. While there are several such initiatives focusing on different domains, the Extractive Industries Transparency Initiative (EITI) and the Resource Governance Index (RGI) produced by the Natural Resource Governance Institute (NRGI) will be most discussed in this work.

Most of the literature above provides examples and discussions of some such initiatives but for a brief and salient overview consult Bleischwitz (2009) and for an extensive and in depth account of the historic development of transparency on the international level consult Haufler (2010). As pointed out by Mejia Acosta (2010), however, the idea of good natural resource governance presents some empirical challenges and different initiatives equate it with different outcomes. The underlying assumption for most advocates of transparency is that increased transparency of information opens up the decision making process to public debate, increases accountability of governments and corporations to the public, all the while improving legitimacy and providing incentives for more efficient financial management. After all "democracy itself is founded on the principle of transparent governance, and efficient markets depend on

full information" (Haufler p55, 2010). Kolstad and Wiig (2009) analyze these assumptions in detail through the different dimensions of transparency and corruption and their links using a principle-agent framework and looking at correlations through regression analysis. Haufler (2010) provides a more qualitative and socio-economic assessment of transparency development while developing a detailed theory of transparency as a concept and its diffusion as an international policy.

However, there is still a debate going on because most of the transparency initiatives and efforts are focusing more on processes rather than actual outcomes. In other words, "while most transparency and accountability initiatives are geared towards attaining an expected or desirable outcome such as improved economic performance or poverty reduction, most project interventions are in fact process-oriented (such as the adoption and validation of EITI status) but it is less clear what are the causal mechanisms that contribute to effective development outcomes" (Mejia Acosta 2010). The weak link in the transparency discourse is proving the causal relationship between transparency measures and actual positive outcomes and improved governance. It is often assumed that just creating a freedom of information law or adhering to a transparency standard will somehow magically transform decision making processes and improve the extractive industry. On the one hand it is too early to tell with certainty considering this is a relatively new development on the international scale and on the other hand this assumption does not do justice to the complexity of the issue. Figure 3 illustrates the assumption behind the EITI and most transparency initiatives that is oft criticized for being too simplistic.

Figure 3 The logic underpinning the EITI (source: Corrigan 2014)

The academic literature is not devoid of skeptics however and several authors have cast a critical look at the actual impacts and improvements of transparency measures (Haufler 2010, Mejia Acosta 2010, Bleischwitz 2009, Kolstad and Wiig 2009, Corrigan 2014, McHenry et al. 2015). What comes out of these works is that the link between transparency and better governance is not linear and as simple as it appears and the effects of transparency can be varied and not even always positive. Many factors come into play because, like everything, transparency does not exist in a bubble, governance is linked to many other factors that can influence it, and transparency of information has a relatively complex qualitative dimension. Too much information, faulty information, hard to understand information, late information, conflicting information can all hinder the expected outcomes and therefore it is important to look at what type of information is being disclosed and in what way is it being disclosed. Another issue worth

considering is the heterogeneous adoption of transparency measures; particularly in the private sector it is hard to convince companies to disclose their information if others are not doing it too because concerns of losing competitive advantages may dissuade companies to be early adopters.

A relatively exhaustive list (Haufler 2010) of the categories of information that can be disclosed includes: details of the call for proposals and bidding process for natural resources exploration and development contracts, the contents and terms of these contracts, payments made by companies to governments (royalties, taxes, signing bonuses, fees), pricing decisions, the size of reserves, the location of resources, exploration, and development, prior informed consent to communities affected by proposed developments, and government budgets for distributing resource rents.

In the words of Kolstad and Wiig (p524, 2009): "in addition to access to information, you need an ability to process the information, and the ability and incentives to act on the processed information". This then implies an informed, well-educated and proactive population that can act on the disclosed information as well as a government with competent employees that are willing to commit to change. Kolstad and Wiig go on to conclude that transparency by itself is not enough to have a significant impact, particularly in countries with high levels of corruption and weak institutions. Therefore, several enabling factors need to be present in order for transparency to reach its potential. One of the most important recommendations to come out of the literature is that transparency initiatives should shift from their focus on resource revenues towards a focus on expenditures because it is the expenditures that would show whether resource wealth is distributed equitably and efficiently. Finally, a critique is pointed at the EITI initiative in that it is too narrow in its scope: "it does not address upstream activities, such as procurement, which constitute a significant part of the value chain in oil and gas, nor does it cover the distribution of income and public expenditure stemming from the extractive industry revenues" (Kolstad and Wiig p527, 2009). Figure 4 illustrates this narrow scope.

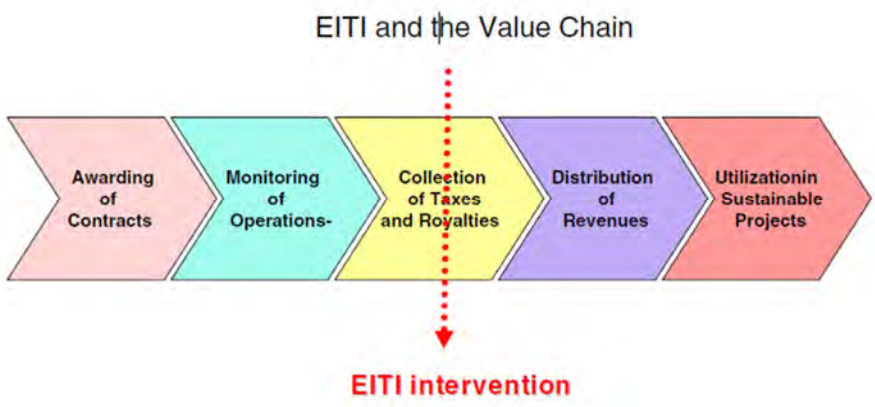


Figure 4 The scope of the EITI (Kolstad and Wiig 2009)

Mchenry et al. (2015) differentiate between disclosure and true transparency, advocate a "simulated user" approach and criticize initiatives like the EITI for lacking consistent data, not including environmental considerations, and having limited effectiveness. They put forward a best practice case

study of an environmental mining securities policy in Western Australia as a near-ideal tool for resolving these problems and creating tangible positive results through transparency and accountability. Even though transparency has become ubiquitous in public and private administration and in resource curse literature it is, nevertheless, a multi-dimensional concept that has multiple layers of meaning, it is politically burdensome and tricky to operationalize.

2.4 Indexes and measuring performance

There are many different approaches to measuring the performance of the extractive industry and the effects of natural resource extraction on the human and natural environment. Considering the cross-cutting and multidimensional nature of the subject this is not surprising. Research from the Integrated natural resource management (INRM) school of thought advocates holistic and integrated approaches that look at all the dimensions of the problem (Lovell et al. 2002, Campbell et al. 2001) and the factors influencing it. The complexity of this field of study is highlighted as a defining factor (Ostendorf 2011) which warrants careful framing and analysis of the ins and outs before determining the approach. This complexity arises from:

- Multiple scales of interaction and response;
- The high frequency of nonlinearities, uncertainty, and time lags in complex systems;
- Multiple stakeholders with often contrasting objectives that complicate the task of identifying research and management aims and finding trade-offs among them;
- The context specificity of INRM sites; and
- The problem of maintaining integration in the face of numerous components and interactions. (Campbell et al. 2001)

The question of scale is put forward as central when considering natural resource management; Lovell et al. (2002) dedicate their work to resolving the issue of differing temporal, institutional, and bio-physical scales. Campbell et al. (2001) also highlight the issue of multiple relevant scales and they propose the sustainable livelihoods approach as a conceptual framework capable of integrating the multiple dimensions and scales of resource management. Within the context of multiple scales the use of GIS tools is helpful and even "self-evident" according to the authors.

Other approaches focus more on the environmental side of the issue and advocate using known methods and frameworks in the context of the extractive industry. The ecosystem services approach (Hinojosa and Hennerman 2012) and the ecological footprint (Swiss Academies of Arts and Sciences 2012) are two well-known methods for quantifying resource use and can therefore be applied to the extractive sector in order to measure its impact. Life cycle assessments are another way of quantifying natural resource and its impacts (ibid.). Finally, some authors advocate the use of system modelling (Campbell et al. 2001, Ostendorf 2011) techniques to bypass problems of lacking data and temporal scales

because it allows for the comparison of model results with real life data and the study of possible future outcomes.

Finally, the improvement and development of GIS methods, parallel to the international growth of the extractive industry, has increased its use in this context as well (Bebbington et al. 2014). Participatory GIS is a relatively novel branch that has garnered some attention and has been applied to the extractive industry domain as a way of fostering local community participation, including local knowledge and perspectives while providing a cost-effective solution to problems of lacking data (Norris 2014). A 2011 (volume 11) special issue of the Ecological Indicators journal provides some examples of using spatial information in a natural resource management context. However, the focus is on renewable resources like forests and fisheries and on the natural side of impacts. A more recent special issue of the Applied Geography journal (2014, volume 54) includes several articles that apply GIS methods to different facets of the extractive industry in an effort to improve its outcomes. These studies (Emel et al. 2014, Cuba et al. 2014, Aistrup et al. 2013, Hinojosa and Hennerman 2012) show the potential of visual information in bringing forth links, interactions, and dynamics that are hard to see otherwise.

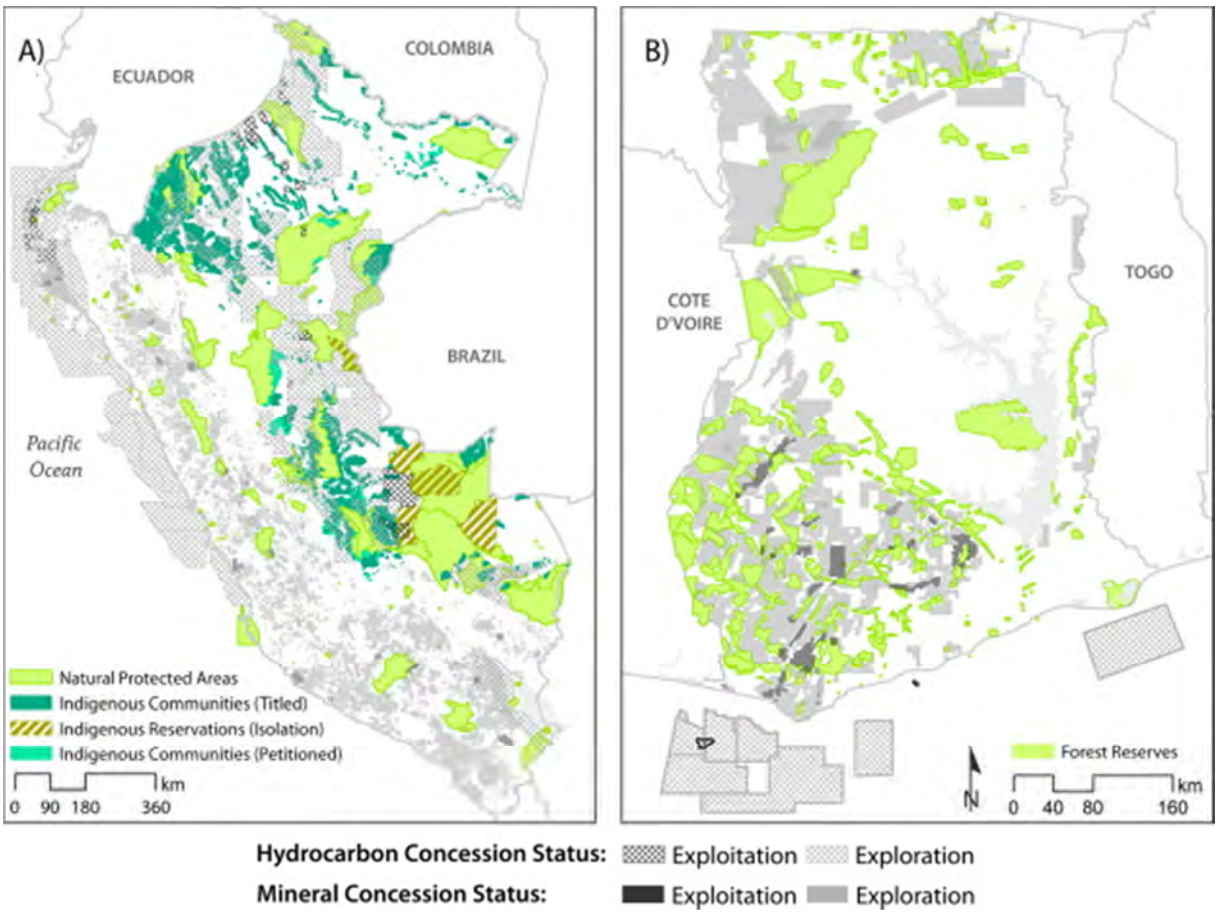


Figure 5 Overlap of mining concessions and protected land use types in Peru (A) and Ghana (B) (Cuba et al. 2014)

The focus of this work is on a particular method of measuring resource governance that is the composite or aggregate index. Indexes are the sort of empirical and quantitative arm of the transparency and governance branch of extractive industry analysis. While initiatives such as the EITI and the Publish

What You Pay campaign set standards and work on a case by case basis, indexes try to quantify concepts such as transparency and governance and give aggregate numerical scores based on this quantification on a global level. There are so-called concept indexes, which measure a single multi-dimensional concept, and policy indexes, which measure policies in a certain sector; policy indexes have received much less attention in academic literature than the concept indexes (Michener 2015). While there is a multitude of concept indexes, one of the most well-known sets of indicators to measure governance on a global level are the World Bank's Worldwide Governance Indicators (WGI). In the case of transparency the Global Open Data Index is well-known and creates scores based only on the transparency of data governments provide and the World Justice Project's Open Government Index is another example of scoring government transparency with a slightly broader scope. The RGI is a policy index and it focuses on the policy domain of governance of natural resources in resource rich countries. Much of it is composed of measures of transparency which follows as a logical link based on the literature review above but a detailed breakdown of its methodology will follow in the next section.

Bleischwitz (2009), echoing the INRM research, argues that transparency is just one avenue towards better resource governance and that additional measures need to be included to measure governance in all its dimensions. In particular, environmental indicators could add validity, measure real effects of extractive operations and not only financial ones, and promote better environmental governance and accountability. "A driving force to include key environmental indicators could be the vision of increasing revenues and public investments for green economies in resource-rich developing countries, with global prosperity stemming from increasing resource efficiency and lowering environmental risks along international value chains." (Bleischwitz p7, 2009) This argument is sound and the RGI could benefit from integrating environmental indicators or be used in conjunction with such already existing measures. However, the development of such a mega index is beyond the scope of this work and indeed beyond the resources of the NRGI. I argue that as a starting point the RGI should make use of GIS technology and methodology to include a spatial component that would facilitate interpretation of the numerical scores and add validity all the while expanding the scope of the index by looking at concrete, spatial manifestations of its governance and transparency scores.

Slack (2014), Bebbington et al. (2014), and McHenry et al. (2015) advocate the added value that mapping and visualizing can bring to the analysis of resource governance. Campbell (p11, 2001) highlights the logic behind this approach: "The problem of defining indicators for systems performance must be addressed at two (or more) levels: a broad level of indicators that help to evaluate the effectiveness of management generally; and, a narrower, more context-specific set of indicators that relate to the particular sociopolitical, economic, and ecological conditions of a defined system". The RGI currently satisfies the first level of analysis but lacks the second level. A spatial component developed with the GIS toolbox could provide the second level.

3. RGI

3.1 Methodology of the RGI

This section is based on the methodology note published by NRGI on their official website that is also included as a section of the full RGI report.

The RGI is a composite index that falls under the category of international transparency policy indexes (Michener 2015). In the words of NRGI it "evaluates the governance of the oil, gas and mining sector in 58 countries" (NRGI 2015). The RGI is presented as a single value score for each country that is assessed and this section will summarize how this score is calculated.

The 58 countries that make up the RGI have not been chosen arbitrarily. They are all hydrocarbon and/or minerals producers. 37 are defined as resource-rich by the International Monetary Fund (IMF) (extractive sector makes up at least 25 per cent of total fiscal income, GDP, or export earnings), four are prospective resource-rich countries, nine have mineral reserves that hold great potential for future fiscal revenue, two (Ghana and Liberia) participate in the Extractive Industries Transparency Initiative (EITI) but are not resource-rich and six of them are among the top 20 producers of hydrocarbons and minerals. Together, they produce 85 per cent of the world's petroleum, 90 per cent of diamonds, and 80 per cent of copper (Revenue Watch Institute 2013).

Three countries (United States, Canada, and Australia) included in the RGI have a federal government structure implying a decentralized governance of natural resources and so the assessment is applied to only one region (Gulf of Mexico, Alberta, Western Australia, respectively). Furthermore, for India, the assessment is focused on the federally governed gas sector.

An important detail to keep in mind is that the index score does not reflect the governance in all three sectors (oil, gas, and mining) in all countries but rather the sector that generates the most revenue in a given country. Each country is evaluated on one sector in particular. While this is mentioned in the methodology section of the RGI report it is not explicitly stated in the individual country fact sheets. While the sector can be implied from the context it would be useful to specify which sector exactly is being evaluated. Figure 6 provides a preview of the index structure by indicator and component.

	Institutional & Legal Setting (20 percent)	
	10 Indicators; 16 Questions	
	Indicators	*Questions*
1	Freedom of information law	
2	Comprehensive sector legislation	
3	EITI participation	
4	Independent licensing process	Licensing authority independent from SOC
		Open and competitive licensing process
5	Environmental and social impact assessments required	Requirement of EI assessment
		Requirement of SI assessment
6	Clarity in revenue collection	Clear authority to collect payments
		Clear transfers of payments to treasury
7	Comprehensive public sector balance	Includes SOC balance
		Includes fund balance
		Includes non-resource balance
8	SOC financial reports required	
9	Fund rules defined in law	Rules for deposits
		Rules for disbursements
10	Subnational transfer rules defined in law	

	Reporting Practices (40 percent)	
	20 Indicators; 122 Questions	
	Indicators	*Questions*
1	Licensing process	Information before licensing
		Information after licensing
2	Contracts	
3	Environmental and social impact assessments	EI assessment
		SI assessment
4	Exploration data	Reserves
		Investment in exploration
5	Production volumes	Production volumes
		Production data by company and/or block
6	Production value	Value of resource exports
		Production costs
		Prices
7	Primary sources of revenue	Value of production streams
		Government's share in PSCs
		Royalties
		Special taxes

	Safeguards & Quality Controls (20 percent)	
	15 Indicators; 35 Questions	
	Indicators	*Questions*
1	Checks on licensing process	Limits to discretionary powers
		Legislative oversight
		Appeal process available
2	Checks on budgetary process	Legislative oversight
		Review of revenue by national audit institution
		Legislature reviews audit reports
3	Quality of government reports	Understandable reports
		Timely reports
4	Government disclosure of conflicts of interest	
5	Quality of SOC reports	Understandable reports
		Timely reports
6	SOC reports audited	Reports are audited
		Audited reports are published
		SOC audits include subsidiaries
7	SOC use of international accounting standards	
8	SOC disclosure of conflicts of interest	

	Enabling Environment (20 percent)	
	5 Indicators	
	Indicators	*Sources**
1	Accountability and democracy	WGI voice & accountability
		EIU Democracy Index
2	Open budget	IBP Open Budget Index
3	Government effectiveness	WGI
4	Rule of law	WGI
5	Corruption	TI Corruption Perceptions Index
		WGI control of corruption

***Each of the Enabling Environment indicators consists of dozens of questions from many sources, including: World Governance Indicators http://info.worldbank.org/governance/wgi/index.asp; International Budget Partnership http://internationalbudget.org/what-we-do/open-budget-survey/; Economist Intelligence Unit https://www.eiu.com/public/topical_report.aspx?campaignid=DemocracyIndex2011; and Transparency International http://cpi.transparency.org/cpi2012/**

Figure 6 Partial preview of the RGI structure by indicator (refer to the RGI website for the full structure)

3.2 RGI Questionnaire

RWI Index Questionnaire: Democratic Republic of the Congo 2012

Category I	**Access to Resources**	
1.1	Context	
1.2	Disclosure	61
1.3	Legal Framework and Practices	67
Category II	**Revenue Generation and Collection**	
2.1	Context	
2.2	Disclosure	29
2.3	Legal Framework and Practices	62
Category III	**State Owned Companies**	
3.1	Context	
3.2	Disclosure	22
3.3	Legal Framework and Practice	50
Category IV	**Natural Resource Funds**	
4.1	Context	
4.2	Disclosure	N/A
4.3	Legal Framework and Practice	N/A
Category V	**Subnational Transfers**	
5.1	Context	
5.2	Disclosure	33
5.3	Legal Framework and Practice	50

Figure 7 Screenshot of the questionnaire structure for the DRC

Each individual country score is produced as a result of a specially designed questionnaire that is composed of a total of 191 questions. Every country questionnaire is accessible online and available for download on the NRGI website. Figure 7 shows an example of a country questionnaire and its general structure. However, some questions have been excluded from the calculation of the final score: 16 questions that are referred to by NRGI as context questions[2], a question on the disclosure of the names of companies operating in the country (duplication), a question on the disclosure of beneficial ownership (incomplete data), and any questions scored as "not applicable". This brings us to the final number of 173 scored questions that are subsequently grouped into 45 indicators. The format and questions are based on standards and guidelines put forth by several external bodies: the IMF's 2007 Guide on Resource Revenue Transparency, EITI, and the Publish What you Pay coalition. "The RGI is therefore a hybrid index largely based on primary data collected through the questionnaire that assesses the governance and transparency of the specific sector, but incorporating several external measures of the context in which oil, gas and mining governance take place." (NRGI 2015) Each question is answered by an expert with comments supporting and explaining the answer, followed by relevant references and links that point to the original sources of information. Figure 8 shows an example of a country questionnaire and individual questions and answers in a particular category.

[2] For example, questions about the authority that grants mining licenses, the existence of state-owned company in the extractive sector, etc.

Given the fact that the individual questions do not have the same structure and categorization of the final indicators it is sometimes difficult navigating between questions and the corresponding indicators. It would be useful to create a diagram that links questions to indicators.

DemocraticRepublicoftheCongo - RWI Index Questionnaire

Disclosure

Back

Indicator		Score
1.2.006	Information on licensing process	84
1.2	Contract transparency	67
1.2.008	Environmental and social impact assessments	25
1.2	Access to information and legislation	67

1.2.006 Information on licensing process

1.2.006.a: What information does the government publish on the licensing process before negotiations?

Score: (A) B C D E

Comments:

Procedures to obtain licenses are clearly spelled out in the Mining Code and Mining Regulation. There are two main procedures. When a concession is barely known, an investor can acquire a research permit and later convert it into an exploitation permit once exploitation seems economically feasible. These procedures are run by the Mines Registry and approved by the Mines Minister. In theory, this procedure is transparent, although some of the publicity rules are not applied in practice, such as the requirement to post pending license requests on the Mines Registry's website (see art. 28 of the Mining Regulation and the relevant page on the Mines Registry's website: http://www.flexicadastre.com/DotNetNukeDRC/Procedures/Formulaires/tabid/131/language/fr-FR/Default.aspx). It is also unclear to which extent the other forms that should ensure sound business practices are carefully monitored and accessible to the public (e.g. environmental impact studies).
When a deposit is well known, the Mining Code offers the possibility to hold bidding rounds. Here again, procedures are clearly spelled out, although this procedure is rarely used.

It should be noted that a third procedure is possible, although much less formal and less regulated. As noted, many investors obtain access to the sector through contracts with SOEs which have valuable titles. These contracting procedures are less clear and often happen in opaque circumstances. After two of the SOEs signed new contracts in secrecy, some of the ministers even opposed the contracts arguing the relevant legal provisions (proscribing a tender process) had not been taken into account.

References:

Art. 28, 43-66, Mining Regulation.

1.2.006.b: What information does the government publish on the licensing process after negotiations?

Score: A (B) C D E

Comments:

Since October 2011, the Mines Registry publishes a monthly updated map reflecting the valid mining permits across the country, along with the name of the title holder, the date the permit was granted, its expected expiration date as well as the list of minerals covered by the permit. In September 2011, it has also published lists of all valid permits per type of permit (research, exploitation, tailings, etc) and per title holder. Since all terms governing the title are fixed in the mining code (tax regime, environmental obligations, duration of the permit, etc), the government does not publish this type of information for each project. The public can technically consult many of the documents filed at the Mines Registry, although some exceptions exist (e.g. feasibility studies) and some of the files are difficult to access in practice.
That said, since many of the investors sign contracts with the SOEs generating an additional set of (financial) obligations, these contracts should also be public. The Ministry of Mines has officially committed to systematic publication, but its implementation remains very partial.

References:

Mines Ministry's website (http://mines-rdc.cd/fr/); Mines Registry's website (http://www.cami.cd)

Figure 8 Example of individual questions and answers in the questionnaire

3.3 Calculating the RGI

The 45 indicators are given a score on a scale from 0 to 100 and are grouped thematically into three so-called components of the final index (Institutional and Legal Setting, Reporting Practices, and Safeguards and Quality Control). However, the amount of questions and indicators per component is not equally distributed with the Reporting Practices component, which is highly transparency focused, containing the majority of questions. There is also a fourth component (Enabling Environment) that is constructed using over 30 external measures and indices created by third parties[3] that are combined into 5 indicators of the broader governance environment. It is worth noting that Michener (2015) warns against "index cannibalism" where indexes incorporate other indexes into their scores. However, the RGI report does contain a section arguing for and against the inclusion of the Enabling Environment external

[3] Economist Intelligence Unit, International Budget Partnership, Transparency International, and Worldwide Governance Indicators

component indicating that the authors are aware of the risks present. Finally, the RGI data tool allows for custom weighting of the 4 components so users can exclude this component from the score.

If an indicator contains more than one question the score is a simple average of the question scores. The component score is also a simple average of the indicator scores. The values of the external indicators for the Enabling Environment component are first normalized to a 0-100 scale. Finally, the RGI score is a weighted average of the four components' scores and is also presented in the form of a single figure on the 0-100 scale that is divided into four performance ranges: 71-100 is satisfactory, 51-70 is partial, 41-50 is weak, and 0-40 is failing.

Table 1: The four components of the RGI

Institutional and Legal Setting	10 indicators calculated from 16 questions that evaluate whether the laws, regulations, and institutional practices enable comprehensive disclosures, open and fair competition, and accountability; 20 per cent weight in the final score.
Reporting Practices	20 indicators calculated from 122 questions that evaluate the actual disclosure of information and reporting practices by government agencies; 40 per cent weight in the final score.
Safeguards and Quality Controls	15 indicators calculated from 35 questions that evaluate the checks and oversight mechanisms that guard against conflicts of interest and undue discretion, such as audits; 20 per cent weight in the final score.
Enabling Environment	Five indicators calculated from more than 30 external sources that evaluate accountability, government effectiveness, rule of law, corruption, and democracy. This component evaluates the extent to which the broader environment will help or hinder transparency and accountability efforts in the extractive industry; 20 per cent weight in the final score.

Finally, margins of error are also calculated as part of the RGI methodology. Margins of error are estimated based on the extent of disagreement across indicators and components. First the simple average of the standard deviation is calculated within and across components providing an average standard deviation across the sample of 8. The implied margin of error around a country's point estimate is calculated to be +/- 13 with a 90 per cent confidence interval. There is also variance across individual countries with a range of 6.5–9.5 which creates different confidence intervals; the top and bottom performers have lower standard deviations in general while those in the middle have higher ones.

It is important to point out that this is the second edition of the RGI index. However, the first edition was a pilot index in 2010 developed solely by the Resource Watch Institute, included only 41 countries, used less questions, and did not estimate margins of error. Given these changes, in the words of

the authors themselves, the 2010 index is not comparable with the current edition. This is rather unfortunate because being able to evaluate the evolution of scores through time is a rather useful feature and would create a more robust measure. It will be interesting to see whether the results of the 2016 RGI will be comparable with the current edition and how this feature will be used.

3.4 Collecting the data

The primary data for the questionnaires, answering all 191 questions for the 58 countries, was collected by a team of researchers composed of 20 local civil society experts, 12 independent consultants based in-country, and 14 experts based outside the country they assessed. However, it is not clear whether these numbers refer to the experts per country or they refer to the totality of the human resources working on all countries. It is not specified in the methodological section at any point which is unusual since there is a big difference between the two cases.

Michener (2015) also warns about the pitfalls of relying on in-country experts that have been documented in the literature, which can create risks of feedback loops and biased information based on perceptions. It is also not clear whether the team of experts filling out the questionnaires is permanent or the team is composed every time a new edition of the RGI is being made and therefore different experts can work on different editions.

4. INCORPORATING GIS TOOLS INTO THE RGI METHODOLOGY

4.1 Critical review of the RGI

While not aiming to discredit the work of the NRGI and the success of the RGI as a resource governance measure several areas for improvement have been identified in the scholarly literature and some interesting geospatial applications in this field have motivated the following proposals for an improved index.

One important recommendation stemming from the literature, directly applicable to the RGI, is the fact that most transparency initiatives and measures focus on resource revenues and not expenditures. The argument is that if we want to measure corruption, development effects, and equitable distribution of resource wealth it is much more important to focus on expenditures rather than revenues (Bleischwitz 2009, Mejia Acosta 2010, Kolstad and Wiig 2009). "There is thus something of a disconnect between prominent current transparency initiatives, and the literature on the resource curse." (Kolstad and Wiig p527, 2009)

Michener (2015) provides a salient analysis of international transparency policy indexes (including the RGI) and looks at their validity from several perspectives. Two of the more important aspects

discussed are content validity[4] and variable substitutability[5]. The RGI receives a positive evaluation of its content validity because it measures several dimensions of transparency as well as de jure and de facto elements. However, it does not go far enough on the question of substitutability since when looking at the production of transparent information it uses categories[6] that do not sufficiently characterize the transparency of information: "The problem here is not only the concept of "distributed to the public", which should be specified, but also the difficulty of differentiating between the first two – "not produced" from "produced for internal purposes" (Michener 2015). An important positive aspect of the RGI is the fact that it disaggregates the data used on the sub-national level. This feature makes it particularly interesting as a candidate for a deeper and potentially spatial use as a governance measure.

Finally, one could argue that the RGI focuses too heavily on transparency as a measure of good governance since 122 out of the 170 questions focus on transparency. It is as much about transparency as it is about governance or rather transparency is put forth as the main measure of good governance known as governance by disclosure or regulation by revelation in the literature (Michener 2015). Furthermore, a significant amount of questions are not applicable to all countries. Because of different institutional arrangements some questions simply do not correspond to the context of certain countries. A section on state-owned companies, for example, cannot be applied to a country like the United Kingdom which does not have state-owned companies and so the score for that country will be based on a smaller number of indicators. Another example are the 20 "reporting practices" questions which are not applicable to Canada (Alberta) because of the institutional arrangements in that case meaning that "Canada's reporting score is based on nearly half as many evaluative queries as other countries" (Michener 2015). This type of mismatch dampens the legitimacy of the measure, creates possible biases toward certain institutional settings, possibly spreads policy isomorphism, and creates inflexible indexes that undermine comparability and applicability across countries (Michener 2015).

As mentioned before, the question of scale has been identified as one of high importance within the context of governance of natural resources. Mechanisms of cause and effect, stakeholder interactions, historic, national and regional contexts, and many other aspects of the extractive industry exist across temporal and spatial scales. In order to evaluate the governance of the sector and potentially improve development outcomes a multi-scale analysis is needed (Gilberthorpe and Papyrakis 2015, Ostendorf 2011). The RGI focuses on the national scale and for the moment is a score of a single year. It would therefore seem that this score does not take into account spatial and temporal scale complexities which makes it vulnerable to missing the whole picture.

---

[4] Content validity is a measure of how completely indexes measure their respective policy domains and concepts: "the RGI provides a good example of multi-dimensional coverage of transparency throughout different stages of the policy cycle" (Michener 2015).

[5] The concept of substitutability is about whether policies have provisions that are interchangeable or there are provisions without which the policy makes no sense and whether this is taken into account in the index. "Lacking public accessibility, a public transparency policy can hardly qualify as transparent" (Michener 2015)

[6] The categories for published documents are: not produced, produced for internal purposes, produced and available on request, produced and distributed to the public

The RGI therefore does not have major gaps in its methodology and seems to adequately capture the evaluation of transparency in the extractive industry. However, transparency is only one measure of governance and the RGI focuses perhaps too much on this proxy. There is definitely potential for a wider scope and improvements can be made to capture more dimensions of governance. Furthermore, the RGI report does not give any room to a theoretical framework of the concepts it purports to measure and it would surely benefit from an in-depth theoretical analysis of these concepts. It is nevertheless a relatively recent project with limited resources which can explain some of these shortfalls and it will be interesting to see its evolution in the future.

4.2 GIS and the RGI

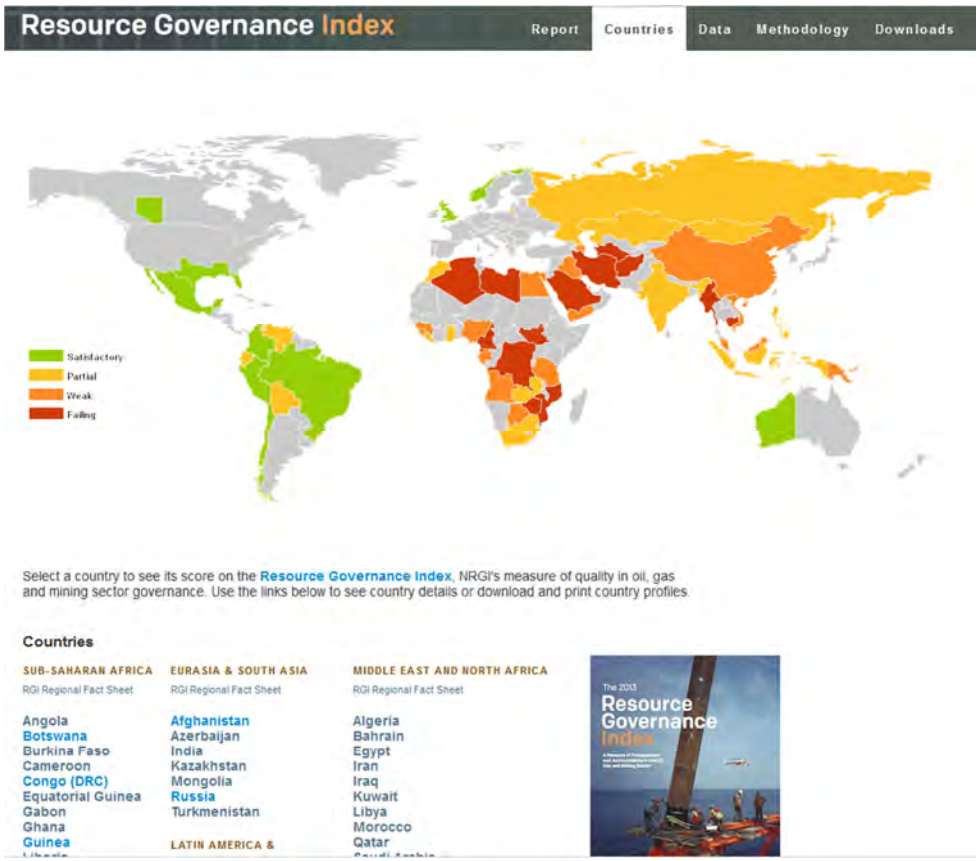
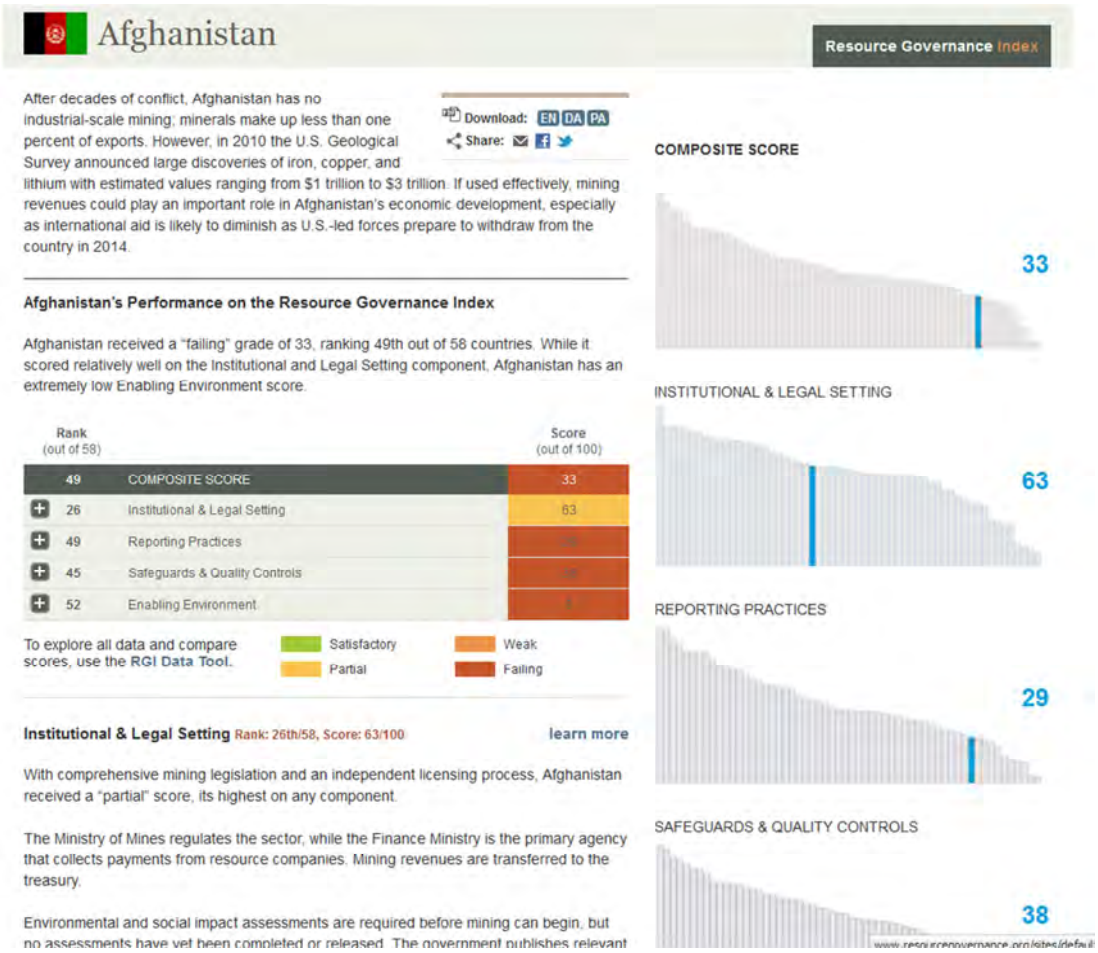


Figure 9 Countries tab on the RGI website

Currently, the RGI website includes a "Countries" tab that presents a visualization of the RGI scores on a global scale and provides links to individual country and regional fact sheets and reports. Figure 9 presents a screenshot of the "Countries" tab on the RGI website. These sections are summaries of the country score broken down by component with graphs visualizing the data, links to download data and to view or download individual questionnaires. There is also a basic online data tool application that allows for interactive data visualization and manipulation. Figure 10 provides a screenshot of an individual country fact sheet and score analysis.



Afghanistan

Resource Governance Index

After decades of conflict, Afghanistan has no industrial-scale mining; minerals make up less than one percent of exports. However, in 2010 the U.S. Geological Survey announced large discoveries of iron, copper, and lithium with estimated values ranging from $1 trillion to $3 trillion. If used effectively, mining revenues could play an important role in Afghanistan's economic development, especially as international aid is likely to diminish as U.S.-led forces prepare to withdraw from the country in 2014.

Download: EN DA PA

Share:

Afghanistan's Performance on the Resource Governance Index

Afghanistan received a "failing" grade of 33, ranking 49th out of 58 countries. While it scored relatively well on the Institutional and Legal Setting component, Afghanistan has an extremely low Enabling Environment score.

Rank (out of 58)		Score (out of 100)
49	COMPOSITE SCORE	33
26	Institutional & Legal Setting	63
49	Reporting Practices	[illegible]
45	Safeguards & Quality Controls	[illegible]
52	Enabling Environment	[illegible]

To explore all data and compare scores, use the RGI Data Tool.

Satisfactory · Partial · Weak · Failing

Institutional & Legal Setting Rank: 26th/58, Score: 63/100 learn more

With comprehensive mining legislation and an independent licensing process, Afghanistan received a "partial" score, its highest on any component.

The Ministry of Mines regulates the sector, while the Finance Ministry is the primary agency that collects payments from resource companies. Mining revenues are transferred to the treasury.

Environmental and social impact assessments are required before mining can begin, but no assessments have yet been completed or released. The government publishes relevant

COMPOSITE SCORE 33

INSTITUTIONAL & LEGAL SETTING 63

REPORTING PRACTICES 29

SAFEGUARDS & QUALITY CONTROLS 38

Figure 10 Example of an individual country fact sheet on the RGI website

In parallel, many countries already have or are putting in place online cadaster registries or portals that map data on concessions, licenses, individual mines, geological information, protected areas, and others. This is a very positive development but ideally all of this information on the extractive industry could be centralized. The Open Government Guide[7] already has the creation of a public online registry of all natural resources concessions as an advanced commitment in the transparency of the extractive industry. Their website is a good example of centralization of existing information from multiple sources. As a first step, the RGI could include a question on the existence of such an online tool in their questionnaire or even a whole section on spatial data and tools available. The argument being that spatial data and tools to use it are very important in the context of governance of natural resources (extractive industries and resources are first of all physical, spatial phenomena). Therefore, the existence of an online mining registry or cadaster can surely be seen as a positive point for natural resources governance. The

[7] Developed by the Transparency and Accountability Initiative in support of the Open Government Partnership the guide presents standards, commitments, and recommendations that governments can undertake in order to achieve transparency and accountability in a range of different domains. Each domain is developed in collaboration with relevant experts and organizations. For each domain it presents relevant organizations, illustrative commitments that can be undertaken separated into three categories (initial, intermediate, and advanced), and existing standards and guidelines.

fact that such a tool exists and is usable by the public also attests to the commitment to transparency of the government providing it. The RGI could, therefore, first of all evaluate whether such tools exist, their quality, and also point to their location so that RGI users can quickly find them.

FlexiCadastre is a company that provides the service of development and management of online mining cadaster portals to governments and has already produced a number of such tools (Botswana, DRC, Kenya, Namibia, Mozambique, Papua New Guinea, Rwanda, South Sudan, Tanzania, Uganda, and Zambia)[8]. Their website even acknowledges the link between the EITI and their work arguing that their tools support the EITI goals. Western Australia's (WA) Department of Mines and Petroleum has a very advanced website with lots of information and spatial data available for their extractive industry. According to McHenry et al. (2015) this is due to policy reform and the resulting Mining Securities Fund. Unfortunately their online map application requires the installation of Microsoft Silverlight which may prevent some users from accessing this tool. However, the main limiting factor of such applications is data availability; figure 11 illustrates this point. "Too often critical spatial information layers are difficult to come by at the appropriate spatial resolution and extent, hence reducing the overall strength of the combined evidence" (Ostendorf 2011). It seems somewhat strange then that the RGI website does not point users to such existing resources that could support the evaluation of resource governance and complement the numerical score. Collaboration between such efforts would greatly improve overall evaluation.

In the words of McHenry et al. (2015): "better outcomes can be achieved by linking voluntary international transparency commitments from governments with mandatory monitoring, analysis, and enforcement of compliance with jurisdictional laws." It is hard to refute this argument when one looks at the level of detail and amount of information present in the WA Department of Mines and Petroleum online map tool. However, the multitude of data makes the tool somewhat harder to navigate, slows down its performance and interestingly enough it is much easier to find individual concessions, owners and operators, and minerals present in the concession on the DRC online map than the WA one (also illustrated in the figure).

[8] Look at http://www.spatialdimension.com/Cadastre-Portals for a list of existing portals and hyperlinks to the respective websites.

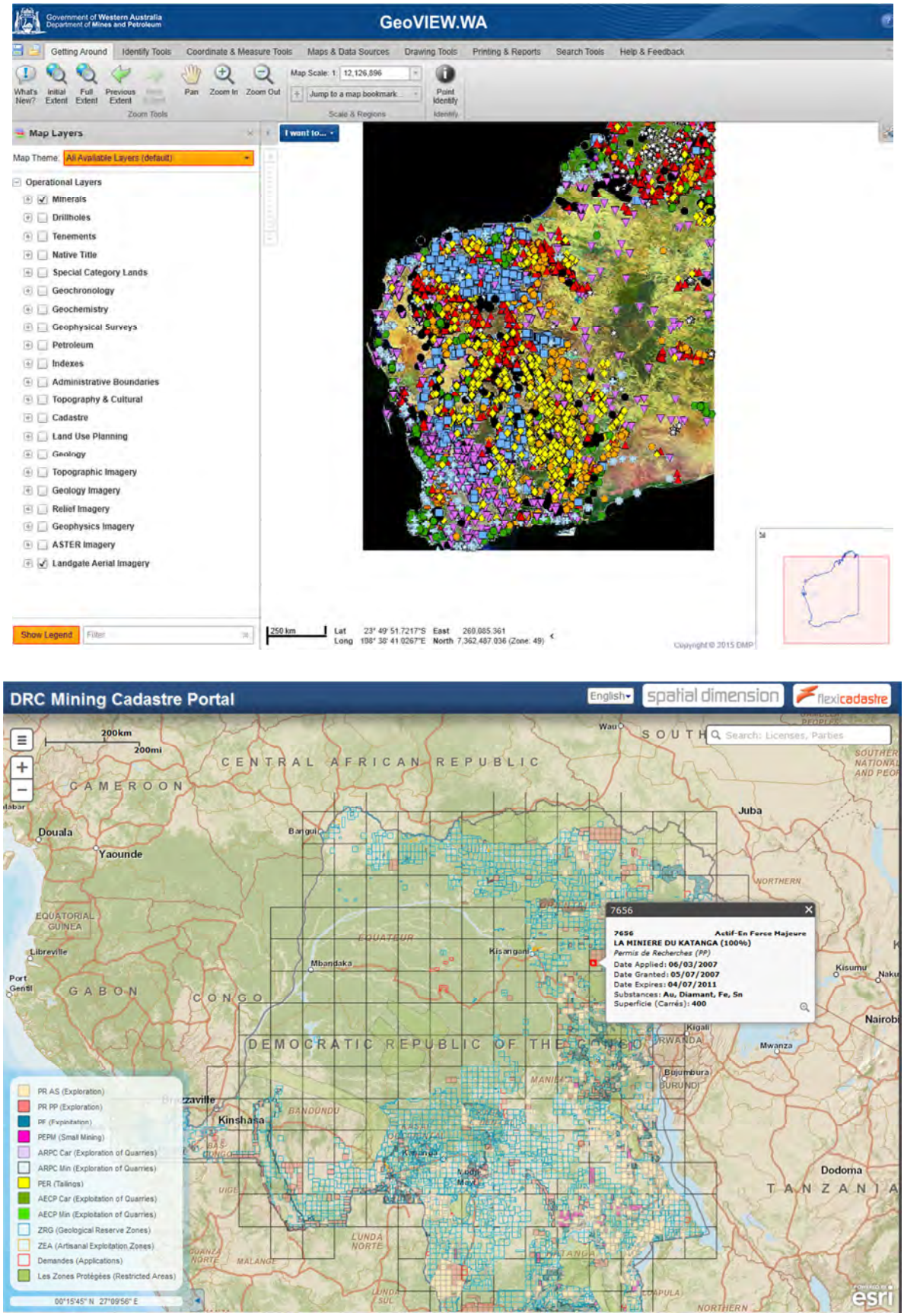


Figure 11 Comparison of available layers and data for the DRC online mining cadastre and the WA mining online map application

As mentioned earlier there have also been academic efforts to tap into spatial information and GIS tools in the context of resource governance and the extractive industry. Norris (2014) argues in favor of the capacity of participatory GIS to bridge the gap between civil society and the state and foster stakeholder interaction. Baynard (2011), Hinojosa and Hennerman (2012), Aistrup et al. (2013), Cuba et al (2014), and Emel et al. (2014) all deploy GIS tools and spatial data in an effort to evaluate impacts, dynamics, and governance of natural resources in specific areas. These studies show the potential of such information, however it is definitely beyond the reach of the RGI to systematically employ such methods and data. For the moment they are pinpoint studies that can hardly be copied to every case and used within the context of an index. Nevertheless, they show the realm of possible and the RGI website could at least point to such existing information and data. Another large effort worth mentioning is the EU EO-MINERS project. There is one example where the RGI report points to such information and that is the Peruvian civil society association Grupo Propuesta Ciudadana which has established an online map portal using public data that allows the viewing of individual mining concessions as well as their overlap with indigenous areas and natural protection zones.

As a first step the RGI should reinforce its theoretical framework and ground its evaluation in some recommendations and findings from academic literature. For example, McHenry et al. (2015) propose five aspects of an ideal mining transparency solution which could be used as a basis for benchmarking existing national solutions. A lot of the criteria are already included in the RGI but there are also many that are not. Considering the fact that most countries analyzed by the RGI have a relatively weak score this approach could further present the state of the sector in a negative light but it would also put things in perspective relative to an ideal solution and even the high performers could see areas where they are lacking. Furthermore, as mentioned before, the focus on revenue data should also be enlarged to include expenditure data (even though realistically this is a very optimistic goal).

Table 2: Five aspects of an ideal mining transparency solution (McHenry et al. 2015)

I.	What the activity is at the site (i.e. tenement, mine-site, downstream processing, infrastructure, pollution such as acid mine drainage, etc.) versus the company (e.g. EITI only considers company level, and the issue of transparency at the macro level, which makes it wholly insufficient for civil society to easily interrogate larger extractive operators with multiple sites on one jurisdiction);
II.	The level of environmental disturbance matched to a detailed plan to correct/rehabilitate the disturbance over time, any incentives to minimize disturbance and/or promote effective rehabilitation, and how success of rehabilitation activities will be determined/measured;
III.	Actual historical performance of correcting disturbance (i.e. disturbance and success of rehabilitation);
IV.	Social data—affected people are consulted and know of decisions, consultation about final post-mining land use and progression toward it, with the social data being available to interested third parties to enable the assessment of fairness (particularly for land owners and traditional custodians); and
V.	Financial flows and transfer of money such as royalties, taxes, any other payments from mining companies (or affiliated subsidiaries or parent companies) to government or community on an individual mine site basis.

A method of using and representing spatial data that would seem particularly appropriate to be implemented in the RGI are so-called story maps. Some existing examples within the context of natural resources are Global Witness' Jade story (https://www.globalwitness.org/jade-story/) which explores the issues and conflicts surrounding jade mining in Myanmar (this example could use more spatial information however), the Twangiza report (http://crowdcover.github.io/geo-report/) done as a pilot example within the Map-X[9] project which explores artisanal mining issues in the Twangiza mine site in the DRC, and the Extractives and Fragile States (http://extractivesfragilestates.github.io/ExtractivesFragileStates/) initiative which maps available data related to the extractive industry in a select number of fragile states.

[9] Map-X is an open data platform developed in collaboration by UNEP, the World Bank and the g7+ secretariat that aims to use open geospatial data to create maps within the context of the extractive industry.

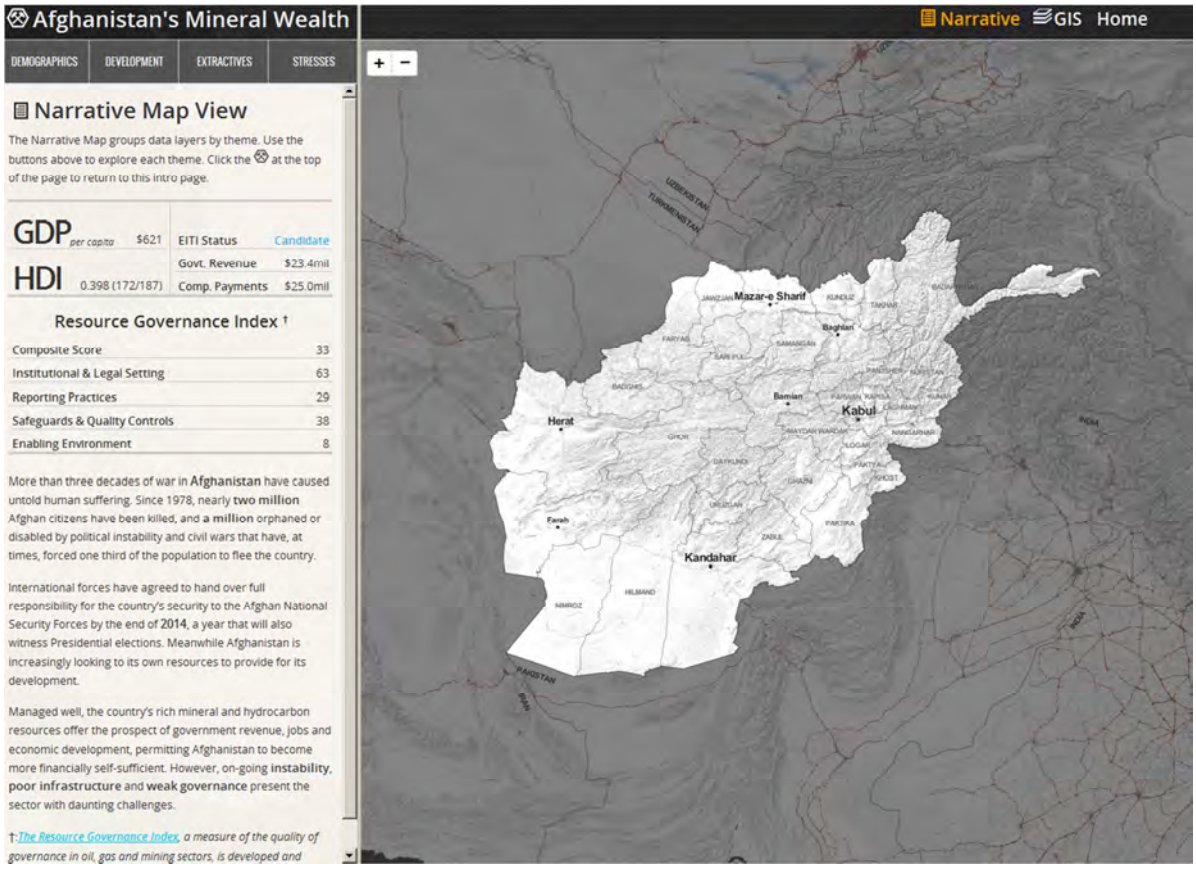


Figure 12 Extractives and fragile states online map application

Figure 12 shows a screenshot of the Extractives and Fragile States webmap tool. We can see that there is a narrative view and a GIS view which can be freely interchanged. The narrative view presents some relevant economic and social indicators, a bit of national context, and even includes the RGI score broken down by component. Furthermore the user can choose between several categories of information and in the GIS view the user can switch between available layers to analyze existing spatial information at a click of the mouse. Depending on existing data a lot of different information can be mapped; for example for the DRC mineral supply chains have been mapped as well as artisanal mines.

Figure 13 shows a screenshot of the Twangiza report story map developed as a pilot for the Map-X project. The screenshot illustrates how several layers of data can be visualized including infrastructure, artisanal mining sites, and protected areas. Yet again this kind of visualization is very powerful : it can transcend scales (in this example the user can zoom in to individual artisanal mining sites or zoom out to the national level), and can provide contextual information in the form of text, photographs, and explanations of particular national dynamics and issues. This kind of represenation can also be used to present time series or maps of the same area over a certain time period and thus expose the temporal dynamics.

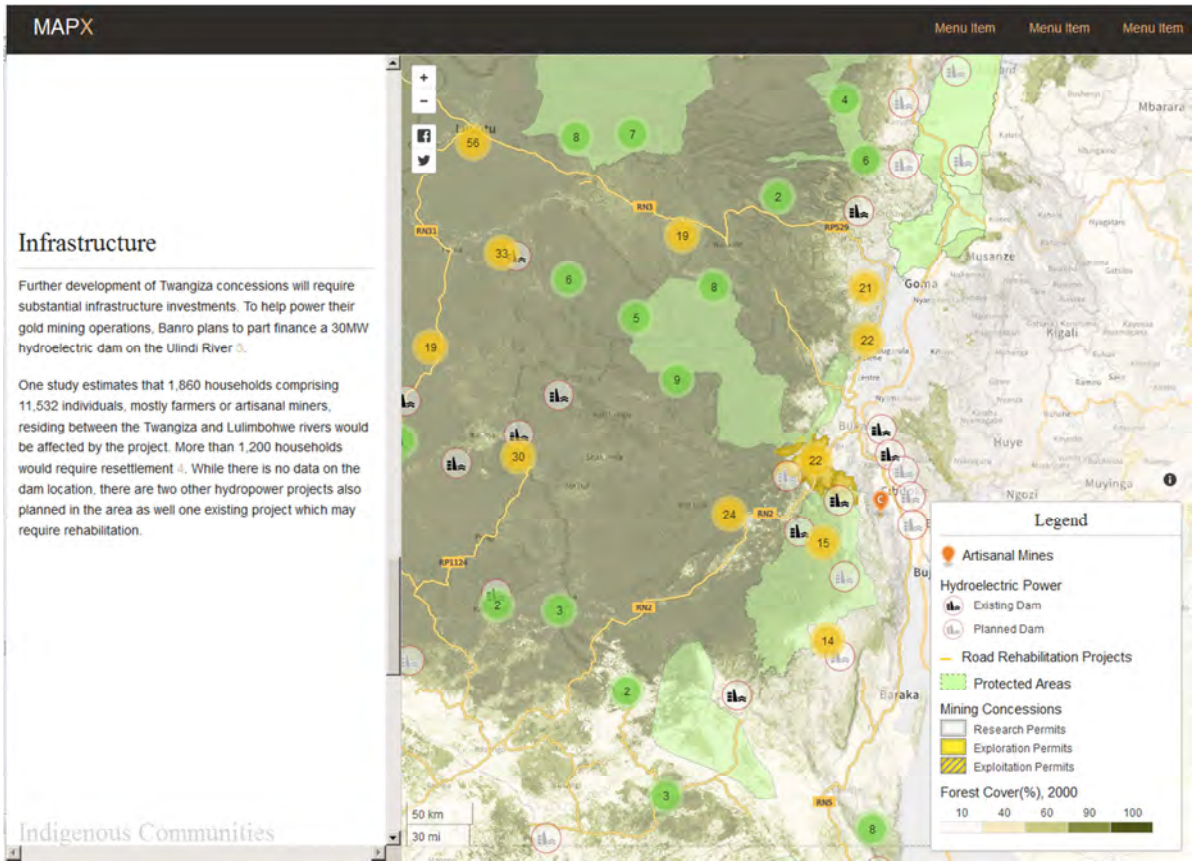


Figure 13 Pilot Twangiza story map from the Map-X project

The RGI "Countries" tab already has a structure resembling that shown in Figures 12 and 13. Each country profile already provides contextual information, other economic and social indicators, and breakdown of RGI indicators. This could be modified and improved to resemble something like the examples above. This would greatly increase the robustness and scope of the RGI and would provide a much more valuable tool to all interested users and parties. Of course, the main problem in this approach is the availability of data. Where there is no available spatial data there can be no maps and considering the low level of transparency and data collection present in most resource rich countries the biggest hurdle is to motivate governments to collect and publish such data or to collect it oneself. This means that this tool would not be used for comparison across countries but would rather provide a more context specific view into the social, economic, environmental, and governance issues of each country. The numerical RGI is comparable and looks at broad factors that can be compared across countries but it does not give us the full picture. Furthermore, the lack of spatial data in certain countries would be immediately evident because the map for that country would be empty. This could be seen as an incentive for that country to populate its map by publishing data but would also clearly communicate the level of governance in that country to the user if even the most basic spatial information is not available.

There is evidence that NRGI is aware of the importance of data availability, especially disaggregated project and contract level spatial data, and that they are advocating its use and following its development. In one communication from their website they announce a new project called

ResourceProjects.org which will be an open repository of project-level identifiers and accompanying data, they refer to spatial data and two academic papers that used it, and even link to a spatial data repository[10] and repositories of other open, relevant data. Even though spatial data is briefly mentioned and the NRGI should focus more on it, this is certainly a very positive development and very close to the efforts argued for in this paper. In another communication[11] they announce the production of an open dataset that has been built from EITI PDF format reports which contains project level data and is free to use. This definitely shows that the RGI authors are well aware of developments around them and are motivated to expand their work and improve the evaluation of resource governance in all ways possible.

It also shows that they already have a certain level of collaboration with the EITI and ways in which these two efforts can mutually benefit from each other's work. Echoing a recent UNEP consultation[12] EITI data could be used to its full potential if it would be adapted to an open data standard. Collaboration between the EITI, projects like MAP-X, and the NRGI would benefit everybody by fostering cooperation and interdisciplinary work, improving the dissemination and use of data, while providing better tools for the evaluation of governance in the extractive industry. A further step would be to include the private sector in this collaboration.

5. CONCLUSION

As we have seen there are many ways in which spatial information and GIS tools can be leveraged for more efficient and robust resource governance evaluation across scales and many sources advocating for its use within this context. It is not a question of whether this approach is pertinent and useful but rather of how it can be best put to use. The authors of the RGI are in a unique position where they can embrace GIS and exploit its potential to become first movers in a world where there is no systematic concerted effort to employ spatial information in combination with a numerical index as of yet. However, the evident barriers to such a positive development are the resources available to use and deploy such data by an organization like the NRGI on the one hand and the production and publication of such data by relevant private and public stakeholders on the other. The answer to this barrier is collaboration between multiple entities and the best way to achieve this is through open data and open source projects in order to leverage the power of many users.

The main questions posed by this paper have been explored through a literature review of relevant concepts and a review of existing GIS methods and efforts deployed in the context of the extractive industry. Several recommendations have been put forth and positive new developments highlighted. Unfortunately, taking into account the time constraints of this paper, some aspects were not treated in as much detail as they merit and further research needs to be done. The two working

[10] See http://a.tiles.mapbox.com/v3/helsinki/maps.html
[11] See : http://www.resourcegovernance.org/news/blog/open-project-data-matters-resourceprojectsorg-how-we-can-make-it-useful and http://www.resourcegovernance.org/publications/dataset-unlocking-eiti-data-meaningful-reform
[12] See : https://eiti.org/files/input_from_unep_on_eiti_open_data_policy.pdf

hypotheses have been confirmed by providing ample arguments and examples of why it is necessary to develop a multi-dimensional and multi-component tool to measure resource governance in addition to or in combination with the RGI and by demonstrating that elements for such a tool already exist. It was not the aim of this work to develop or implement these recommendations, considering it would be a sizeable effort, but rather to start a debate on the matter, analyze several possibilities and offer a direction in which further work on this subject could follow.

While resource governance is a complex and multifaceted issue that is hard to operationalize there are many efforts made to eliminate this problem and GIS tools and spatial information seem to be particularly suited to at least improve the current situation. The transparency movement is well underway and it does not seem overly optimistic to expect more and more data on all levels being made available and put to good use in the coming years. While the RGI is not without gaps and is still relatively young it is a good base for comparative resource governance evaluation that could be (and surely will be) improved by integrating spatial information and further developing individual country profiles. All the stars are aligned for further developing systematic and holistic resource governance evaluation tools that have the potential to profoundly influence and change for the better this industrial sector in need of efficiency and sustainability.

6. BIBLIOGRAPHY

Aistrup, Joseph A., László J. Kulcsár, Jacob A. Mauslein, Sarah Beach, and David R. Steward. 2013. "Hyper-Extractive Counties in the U.S.: A Coupled-Systems Approach." *Applied Geography* 37 (February): 88–100. doi:10.1016/j.apgeog.2012.09.010.

Alstine, James Van. 2014. "Transparency in Energy Governance: The Extractive Industries Transparency Initiative and Publish What You Pay Campaign" In *Transparency in Global Environmental Governance: Critical Perspectives.* MIT Press Scholarship Online. doi: 10.7551/mitpress/9780262027410.003.0011

Barrett, Christopher B., Clark C. Gibson, Barak Hoffman, and Mathew D. McCUBBINS. 2006. "The Complex Links between Governance and Biodiversity." *Conservation Biology* 20 (5): 1358–66. doi:10.1111/j.1523-1739.2006.00521.x.

Bebbington, Anthony J., Nicholas Cuba, and John Rogan. 2014. "Visualizing Competing Claims on Resources: Approaches from Extractive Industries Research." *Applied Geography* 52 (August): 55–56. doi:10.1016/j.apgeog.2014.04.015.

Bleischwitz, Raimund. 2014. "Transparency in the Extractive Industries: Time to Ask for More." *Global Environmental Politics* 14 (4): 1–9. doi:10.1162/GLEP_e_00254.

Busse, Matthias, and Steffen Gröning. 2013. "The Resource Curse Revisited: Governance and Natural Resources." *Public Choice* 154 (1-2): 1–20. doi:10.1007/s11127-011-9804-0.

Campbell, Bruce, Jeffrey A. Sayer, Peter Frost, Sonja Vemeulen, Manuel Ruiz Pérez, Anthony Cunningham, and Ravi Prabhu. 2001. "Assessing the Performance of Natural Resource Systems." *Ecology and Society* 5 (2). http://www.ecologyandsociety.org/vol5/iss2/art22/.

Corrigan, Caitlin C. 2014. "Breaking the Resource Curse: Transparency in the Natural Resource Sector and the Extractive Industries Transparency Initiative." *Resources Policy* 40 (June): 17–30. doi:10.1016/j.resourpol.2013.10.003.

Cuba, Nicholas, Anthony Bebbington, John Rogan, and Marco Millones. 2014. "Extractive Industries, Livelihoods and Natural Resource Competition: Mapping Overlapping Claims in Peru and Ghana." *Applied Geography* 54 (October): 250–61. doi:10.1016/j.apgeog.2014.05.003.

Cust, James, and Steven Poelhekke. 2015. "The Local Economic Impacts of Natural Resource Extraction." *Annual Review of Resource Economics* 7 (1): 251–68. doi:10.1146/annurev-resource-100814-125106.

Emel, Jody, Joshua Plisinski, and John Rogan. 2014. "Monitoring Geomorphic and Hydrologic Change at Mine Sites Using Satellite Imagery: The Geita Gold Mine in Tanzania." *Applied Geography* 54 (October): 243–49. doi:10.1016/j.apgeog.2014.07.009.

Frankel, Jeffrey. 2010. "The Natural Resource Curse: A Survey." w15836. Cambridge, MA: National Bureau of Economic Research. http://www.nber.org/papers/w15836.pdf.

Gaventa, John, and Rosemary McGee. 2013. "The Impact of Transparency and Accountability Initiatives." *Development Policy Review* 31 (July): s3–28. doi:10.1111/dpr.12017.

Gupta, Aarti and Mason, Michael. "*Transparency in Global Environmental Governance: Critical Perspectives*" Cambridge: The MIT Press, 2014. Project MUSE. Web. 13 Jan. 2016.

Gilberthorpe, Emma and Papyrakis, Emma. "The extractive industries and development: The resource curse at the micro, meso and macro levels", *The Extractive Industries and Society* 2(3):381–390, April 2015. http://dx.doi.org/10.1016/j.exis.2015.02.008.

Haufler, Virginia. 2010. "Disclosure as Governance: The Extractive Industries Transparency Initiative and Resource Management in the Developing World." *Global Environmental Politics* 10 (3): 53–73. doi:10.1162/GLEP_a_00014.

Helen Markelova, and Esther Mwangi. 2010. "Multilevel Governance and Cross-Scale Coordination for Natural Resource Management: Lessons from Current Research." http://wealthofthecommons.org/essay/multilevel-governance-and-cross-scale-coordination-natural-resource-management-lessons-current.

Hinojosa, Leonith, and Karl Hennermann. 2012. "A GIS Approach to Ecosystem Services and Rural Territorial Dynamics Applied to the Case of the Gas Industry in Bolivia." *Applied Geography* 34 (May): 487–97. doi:10.1016/j.apgeog.2012.02.003.

Kaufmann, Daniel. 2015. "Evidence-Based Reflections on Natural Resource Governance and Corruption in Africa." In *Africa at a Fork in the Road: Taking off or Dissapointment Once Again?*. Yale Center for the Study of Globalization. http://www.ycsg.yale.edu/assets/downloads/africa.pdf.

Kaufmann, Daniel, and Ana Bellver. 2005. "Transparenting Transparency: Initial Empirics and Policy Applications." *SSRN Electronic Journal*. doi:10.2139/ssrn.808664.

Kolstad, Ivar, and Tina Søreide. 2009. "Corruption in Natural Resource Management: Implications for Policy Makers." *Resources Policy* 34 (4): 214–26. doi:10.1016/j.resourpol.2009.05.001.

Kolstad, Ivar, and Arne Wiig. 2009. "Is Transparency the Key to Reducing Corruption in Resource-Rich Countries?" *World Development* 37 (3): 521–32. doi:10.1016/j.worlddev.2008.07.002.

Lovell, Chris, Alois Mandondo, and Patrick Moriarty. 2002. "The Question of Scale in Integrated Natural Resource Management." *Ecology and Society* 5 (2). http://www.ecologyandsociety.org/vol5/iss2/art25/.

McHenry, M.P., A. Morrison-Saunders, P. Gorey, A. Rita Sequeira, H. Mtegha, and D. Doepel. 2015. "Puzzled: Navigating Extractive Policy Information Jigsaws for Best Practice and Transparency." *The Extractive Industries and Society*, May. doi:10.1016/j.exis.2015.05.004.

Moreno-Pires and Teresa Fidélis. 2012. "A proposal to explore the role of sustainability indicators in local governance contexts: The case of Palmela, Portugal" *Ecological Indicators* 23:608–615. doi:10.1016/j.ecolind.2012.05.003

Mejía Acosta, Andrés. 2013a. “The Impact and Effectiveness of Accountability and Transparency Initiatives: The Governance of Natural Resources.” *Development Policy Review* 31 (July): s89–105. doi:10.1111/dpr.12021.

———. 2013b. “The Impact and Effectiveness of Accountability and Transparency Initiatives: The Governance of Natural Resources.” *Development Policy Review* 31 (July): s89–105. doi:10.1111/dpr.12021.

Michener, Gregory. 2015. “Policy Evaluation via Composite Indexes: Qualitative Lessons from International Transparency Policy Indexes.” *World Development* 74 (October): 184–96. doi:10.1016/j.worlddev.2015.04.016.

Natural Resource Governance Institute. 2013. “The 2013 Resource Governance Index.” Revenue Watch Institute. http://www.resourcegovernance.org/sites/default/files/rgi_2013-webreport.pdf.

Norris, Timothy B. 2014. “Bridging the Great Divide: State, Civil Society, and ‘participatory’ Conservation Mapping in a Resource Extraction Zone.” *Applied Geography* 54 (October): 262–74. doi:10.1016/j.apgeog.2014.05.016.

Ostendorf, Bertram. 2011. “Overview: Spatial Information and Indicators for Sustainable Management of Natural Resources.” *Ecological Indicators* 11 (1): 97–102. doi:10.1016/j.ecolind.2010.10.003.

Pahl-Wostl, Claudia. 2009. “A Conceptual Framework for Analysing Adaptive Capacity and Multi-Level Learning Processes in Resource Governance Regimes.” *Global Environmental Change* 19 (3): 354–65. doi:10.1016/j.gloenvcha.2009.06.001.

Shaxson, Nicholas. 2007. “Oil, Corruption and the Resource Curse.” *International Affairs* 83 (6): 1123–40. doi:10.1111/j.1468-2346.2007.00677.x.

Slack, Keith. 2014. “Mapping the Bigger Picture: Using Mapping to Promote Better Development Outcomes from Extractive Industries.” *Applied Geography* 54 (October): 237–42. doi:10.1016/j.apgeog.2014.05.017.

Somogyi, Zoltan. 2016. “A Framework for Quantifying Environmental Sustainability.” *Ecological Indicators* 61 (February): 338–45. doi:10.1016/j.ecolind.2015.09.034.

Swiss Academies of Arts and Sciences. 2012. “Measuring the Use of Natural Resources.” Swiss Academies of Arts and Sciences. http://www.satw.ch/publikationen/schriften/Indikatoren-Broschuere_EN.pdf.

Treib, Oliver, Holger Bähr, and Gerda Falkner. 2007. “Modes of Governance: Towards a Conceptual Clarification.” *Journal of European Public Policy* 14 (1): 1–20. doi:10.1080/135017606061071406.

Uhlmann, Vikki, Will Rifkin, Jo-Anne Everingham, Brian Head, and Kylie May. 2014. “Prioritising Indicators of Cumulative Socio-Economic Impacts to Characterise Rapid Development of Onshore Gas Resources.” *The Extractive Industries and Society* 1 (2): 189–99. doi:10.1016/j.exis.2014.06.001.