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Article

A Tool to Measure Sustainability in Biosphere Reserves Located in Prosperous Countries

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Abstract:
Since last century, humanity has been using and disposing resources at a greater rate than the Earth's biocapacity to regenerate[1]. Consequently, habitats are being destroyed, climate is changing and, for most, life conditions are deteriorating. To avoid collapse, humanity has been, at least in theory, trying to change the foundations of development so that it becomes 'sustainable' and, while meeting the social, economic and environmental needs of the present, does not compromise the ability of future generations to meet their own needs[2]. To help on this task, in the 1960s, UNESCO proposed the establishment of laboratories for developing and testing sustainable approaches. These became known as Biosphere Reserves or, simply, Biospheres. Today, there are more than 700 Biospheres in over 120 countries around the world, and at least one-third of them are located in prosperous countries that have human development levels equal or above 0.9[3].

Biospheres are nominated by national governments and are recognised by the Man and Biosphere International Coordinating Council (MAB-ICC). They are managed and planned with the active participation of local communities and of relevant stakeholders[4], and are reviewed by the MAB-ICC every ten years to improve their quality and functioning "as sites for testing and demonstrating approaches to sustainable development"[5]. Since 2013, the monitoring process of Biospheres is based on the Statutory Framework of the World Network of Biosphere Reserves[5], which focuses on the main changes that occurred in each Biosphere since its creation or its last review process. This framework consists of a questionnaire with mostly open-ended questions focused on a series of parameters that are appraised with descriptive answers. The qualitative approach used in this framework is believed to be effective for subjectively understanding the processes of changes within Biospheres and, hence, can be used to direct future actions and to learn lessons applicable to other Biospheres.

While the MAB-ICC review takes place every ten years, each Biosphere needs to regularly monitor its own progress to adapt management when and if necessary. The framework used by the MAB-ICC could potentially be used for this monitoring process, yet it is extensive (the questionnaire has 43 pages) and does not consider particularities and priorities of each Biosphere. As such, each Biosphere usually develops their own mechanism for monitoring progress.

Due to the qualitative approach used by the MAB-ICC and the different monitoring mechanisms adopted by each Biosphere, today, to objectively compare the level of effectiveness of different approaches or simply through time is not possible. Thus, an objective tool that can potentially be adopted by several Biospheres to measure sustainability is still necessary. Presenting such a tool is the objective of this article.

Key words: Sustainability; Biosphere Reserves

[1] Global Footprint Network. *Earth Overshoot Day marked the launch of 100 Days of Possibility leading to COP26*. 2021 [cited 2021 Oct 07]; Available at: https://www.footprintnetwork.org/

[2] World Commission on Environment and Development. *Our Common Future*. 1987.

[3] UNESCO. *Biosphere Reserves*. 2020; Available at: https://en.unesco.org/Biosphere/about.

[4] UNESCO. *Designation and Review Process*. 2019 [cited 2021 03/03]; Available at: https://en.unesco.org/Biosphere/designation.

[5] UNESCO. *Periodic Review of Biosphere Reserve*. 2013 [cited 2021 03/03]; Available from: https://en.unesco.org/sites/default/files/periodic_review_form_english_2013.pdf.

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Background

This work was initiated by the Sunshine Coast Council (Queensland, Australia), in the context of the establishment of a local Biosphere. For this end, the Council requested a framework with a set of indicators to measure sustainability within the region. Additionally, they required information on the condition of each indicator, context, goals, targets and delivery dates; and that the selected indicators and targets were based on local, state, national and international policies and standards, and on readily available data. They also requested that the framework considered the region's motto, which is to become Australia's most sustainable region, for which the framework needed to be applicable in other Biospheres located in prosperous countries, so to allow comparison.

The methodological process of developing the framework requested by the Sunshine Coast Council included two major steps. The first followed a circular movement, alternating (1) review of secondary sources, such as policies and censuses, (2) intense discussion and consultation with the consulting team and with key stakeholders and (3) establishment of (temporary) indicators. Indicators and the structure in which they were organised were considered temporary until consensus was reached about the optimum framework. This circular process took about one year with about one session of discussion per fortnight.

The first core discussion focused on what constitutes sustainability in a country with a very-high level of human development, as is the case of Australia. This discussion was necessary as what constitutes sustainability is still open for discussion.

The most recent and globally accepted description of sustainability was proposed by the UN in the first half of the 2010s, when, through the most inclusive and comprehensive negotiation of the UN history, the UN Member States defined the most urgent matters to be dealt with in the context of sustainability. These became known as the 17 Sustainable Development Goals (SDGs), which aspire "to ensure prosperity and well-being for all women and men, while protecting our planet and strengthening the foundations for peace"[6]. According to these SDGs, by the time sustainability is achieved there will be no poverty or hunger. People will have good health and well-being and will have access to quality education. There will be gender equality; clean water and sanitation; affordable and clean energy; decent work and economic growth; and industry, innovation and infrastructure. Inequalities will be reduced; consumption and production will be responsible. Life below water and above land will thrive. People will take action in regard to climate change and will set partnerships for global and common goals. There will be peace, justice and strong institutions to support the achievement of the goals.

While this description of sustainability seems ample, it largely portrays the reality of prosperous countries, such as Australia, Norway and Switzerland, where (local) issues such as poverty, hunger and access to water, sanitation, energy, education and health services have been largely resolved. This association becomes more obvious in Figure 1, which (using UN's official indexes) relates countries' level of human development[7] (x-axis) and countries' level of sustainability[8] (y-axis). The clear trend of this correlation (R^2 =0.8495) suggests that sustainability is, now, mainly a burden for the poorer countries, as the more prosperous ones have nearly arrived 'there'.

[6] UNESCO. *Moving forward the 2030 Agenda for Sustainable development*. 2015. [cited 2021 Oct 07]; Available at:https://en.unesco.org/creativity/files/unesco-moving-forward-2030-agenda-sustainable

[7] UNESCO. *Human Development Index*. 2022 [cited 2022 July 21]; Available at: https://hdr.undp.org/data-center/human-development-index#/indicies/HDI

[8] Sachs, J. *et all*. *Sustainable Development Report 2021. A Decade of Action for the Sustainable Development Goals*. 2021 [cited 2022 July 21]; Available at: https://www.google.com.au/books/edition/Sustainable_Development_Report_2021/Qvw7EAAAQBAJ?hl=en&gbpv=1&printsec=frontcover

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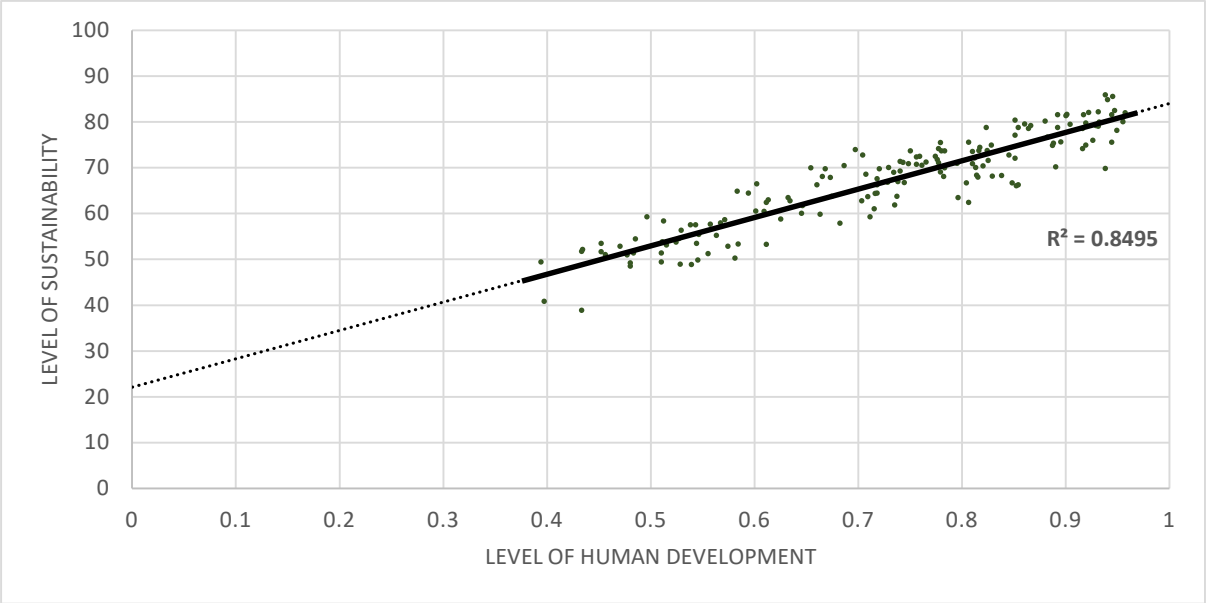

Figure 1: Level of Human Development[7] vs. Level of Sustainability[8]

Such appraisal, based on which the indexes of sustainability and of human development closely compare, was considered dangerous by the consulting team, as most of the current global ecological problems, such as climate change for example, were initiated and continue to be intensified by the wealthiest countries and, most importantly, will not be resolved without radical changes to our consumerist culture, which may not cause pollution or impoverishment within the boundaries of our countries but does so elsewhere. As such, it was understood that if the Sunshine Coast Biosphere is to really push progress towards sustainability, then a more fluid understanding of sustainability is fundamental. One in which sustainability is not considered a "fixed state of harmony" [9], as measurable within limited boundaries, but a state of constant and purposeful improvement towards a state in which Oikos is in dynamic harmony. Sustainability, then, consists of a direction not a destination, and is a challenge and a responsibility common to all humanity. Therefore, all - including the wealthiest and the poorest - should put similar effort into achieving it.

This does not mean, however, that all should take similar actions but that all should contribute as possible (and not as convenient) to the common goal of sustainability. Based on this understanding, what constitutes sustainability is largely context related. As such, the understanding of the consulting team was that SDGs need to be recalibrated based on local realities or, more precisely, on the level of human development of the place that is being assessed.

The second core discussion with the consultant team was around the structure of the framework to measure sustainability. The framework used by UNESCO's official index considers (1) that sustainability will have been reached once the 17 SDGs have been achieved and (2) that SDGs are similarly important, which transcribes to something such as Figure 1.

Figure 2: Conceptual framework used by Sachs et all[8] to assess sustainability

While logical and simple, this understanding disregards the fact that many of the 17 SDGs overlap (especially when considered in the context of prosperous countries); hence, with this structure, some issues are double counted. For example, SDGs 1 and 2 aim at ending poverty and hunger (or food insecurity, if in the context of prosperous countries). Yet, food insecurity in prosperous countries is not usually caused by generalised food shortage in supermarkets but by limited economic resources to buy food. Therefore, once poverty is solved, there will no longer be food insecurity in prosperous countries. Other examples of overlaps include SDGs 5 and 10, with both aiming at reducing inequalities, and SDG 11, which aims at sustainable cities and

[9] World Commission on Environment and Development. *Our Common Future*. 1987.

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communities and refers back to the other 16 SDGs. Overlaps could be interpreted as indicatives that some SDGs are more important than others, which would justify the double count. Yet, are poverty and equality, for example, more important than peace, education, health and clean environments? There is no evidence to suggest so. Instead, evidence suggests that most factors related to sustainability are highly interconnected; thus, the quality of one SDG affects the quality of all others, creating intense feedback loops. In this context, all of the core goals are similarly important, which means that avoiding overlaps and double count is essential. This was achieved by reorganizing the contextualised SDGs into the framework currently used in the management of Biospheres, which subdivides sustainability into four topics: society, economy, natural resources and governance. As there is no single SDG or indicator that can be used to adequately measure the state of any of these topics - and following the common scholarly approach of fragmenting complex issues into more manageable parts -, in the context of the Sunshine Coast Biosphere, topics were further subdivided into criteria and indicators. So, for example, the topic natural resources was fragmented into protection, use and disposal of resources, and each of these criteria were sub-fragmented into indicators, such as biodiversity and protected areas, which indicate elements or issues that are largely significant to most Biospheres located in prosperous countries. Different geopolitical regions, however, tend to use different measures to gage similar things. This was incorporated into the framework with a further fragmentation of indicators into measures, which are to reflect local censuses and available data and, hence, may largely vary among Biospheres. As an example, the indicator 'protected area' will be assessed in the Sunshine Coast Biosphere by the measure 'percentage of land publicly owned and legally protected for the purpose of long-term conservation', elsewhere, depending on how this is monitored, it might be 'percentage of land legally protected for the purpose of conservation'.

Following this structure, the framework presented by the consulting team to the Council subdivided sustainability into four hierarchical levels: topics, criteria and indicators, which convey to all Biospheres, especially those located in prosperous countries, and measures, which are site specific. Within the four topics, it contemplated 17 criteria, 55 indicators and 186 measures with related targets. The timeframe for reviews was established for five-years, as this corresponds to the middle of the trajectory between MAB-ICC mandatory reviews, giving time for Biospheres to improve management in problematic areas, if necessary. Additionally, in many countries this corresponds to the periodicity of national censuses, which supplies much of the necessary data for assessing sustainability.

In short, the framework presented to the Council encompasses the idea that in Biospheres located in prosperous countries:

- societies should be wealthy enough so that all can live with dignity, can be healthy, can enjoy life, and can have access to good education; there should be equity among all people, independently of gender, ethnicity or others, and justice and peace should be fostered;
- natural resources should, in one hand, be protected, both in land and in the ocean, by the government and through voluntary actions; and, in the other, should be used and disposed responsibly and based on efficient and clean technologies, so to avoid overuse while mitigating climate change and pollution;
- economies should create the grounds for the fair distribution of resources and should be abundant so that, while all can live with dignity, governments have financial capacity to guide progress towards sustainability; they should offer decent jobs; be diverse so to be resilient in times of crisis and open for the flourishing of local enterprises; and should be based in good practices that engender confidence in investors while protecting peoples and environments; and
- governances should focus on the above as well as on the adaptation to climate change - aiming at minimising threats with proper education, policies and insurances -; on establishing strong connections and cooperation with relevant others, and on promoting a public image that is in accordance with the local reality and with how the community wants to be perceived.

These ideas are conceptually represented in Figure 4. Criteria, indicators, measures, goals and targets suggested for measuring sustainability in Sunshine Coast Biosphere are detailed in Attachment I[10] and, in Attachment II, these are synthetised alongside local data and a colour scheme, which was used to facilitate the understanding of the situation. Different colours were used to indicate whether measures were moving

[10] Within this document, all underlined texts are hyperlinks.

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away (red) or towards (yellow) the target, are stable (orange) and or if the target has already been achieved (green).

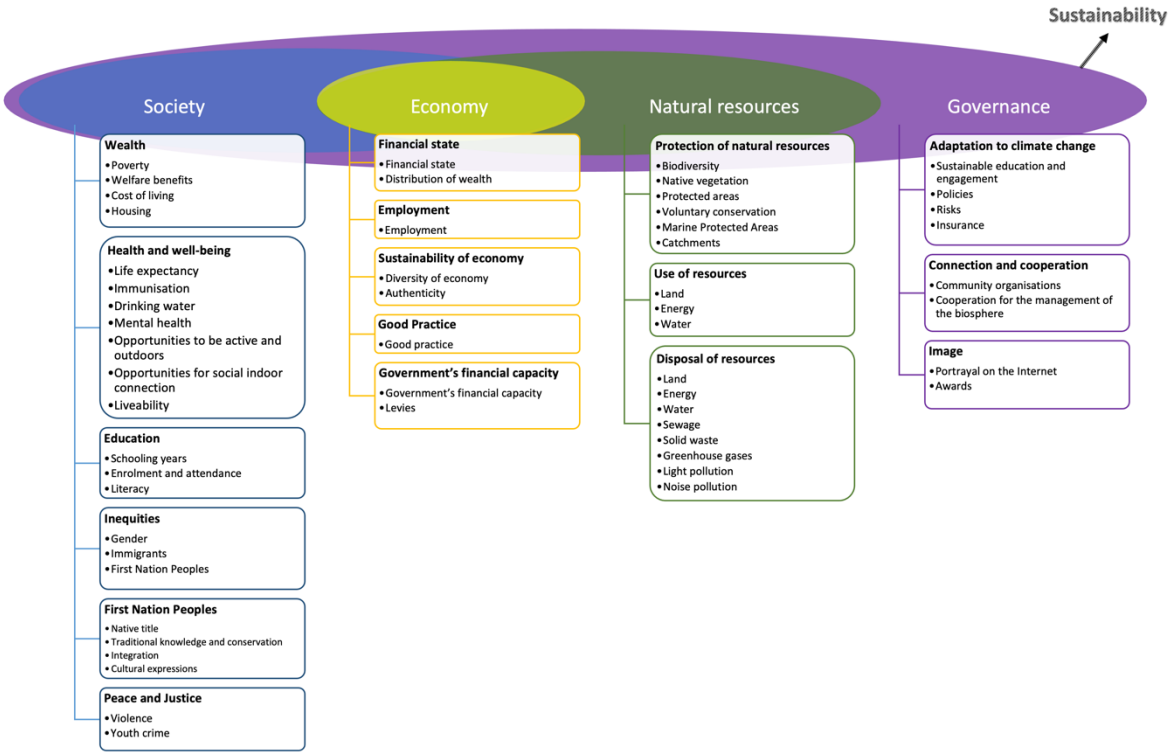

Figure 3: Conceptual representation of sustainability in the context of Biospheres located in prosperous countries (topics, criteria and indicators)

With the presentation of the above, the consultancy reached to an end. With this, the second major step of the methodological process followed for developing the framework that will be used to assist on measuring sustainability in the Sunshine Coast Biosphere started. It focuses on further aligning the framework presented by the consulting team to the aspirations of the Council. For this end, the Council is promoting internal discussions that involves representatives of all, or at least most, of its local departments. This methodological step is still taking place.

An algorithm to make sense of sustainability

Having ended the consultancy process, some scholarly questions arose, such as how to combine 186 diverse measures in a meaningful way that allows to objectively assess sustainability; how to know if the defined targets are achievable and yet aspirational; and how to compare how much effort is necessary to achieve the targets established by each Biosphere? An algorithm fit for the purpose can help on answering these questions. An algorithm consists of a set of rules and instructions defined to reach a specific outcome, in this case, to measure progress towards sustainability in Biospheres located in countries with very high levels of human development.

The set of instructions for such algorithm would ideally follow the standard procedure of planning processes, i.e., adjust the assessment framework to the local conditions and existing data and policies; populate the framework with data on the selected measures; analyse the data; consult with relevant stakeholders; and then repeat the process every five years (Figure 5).

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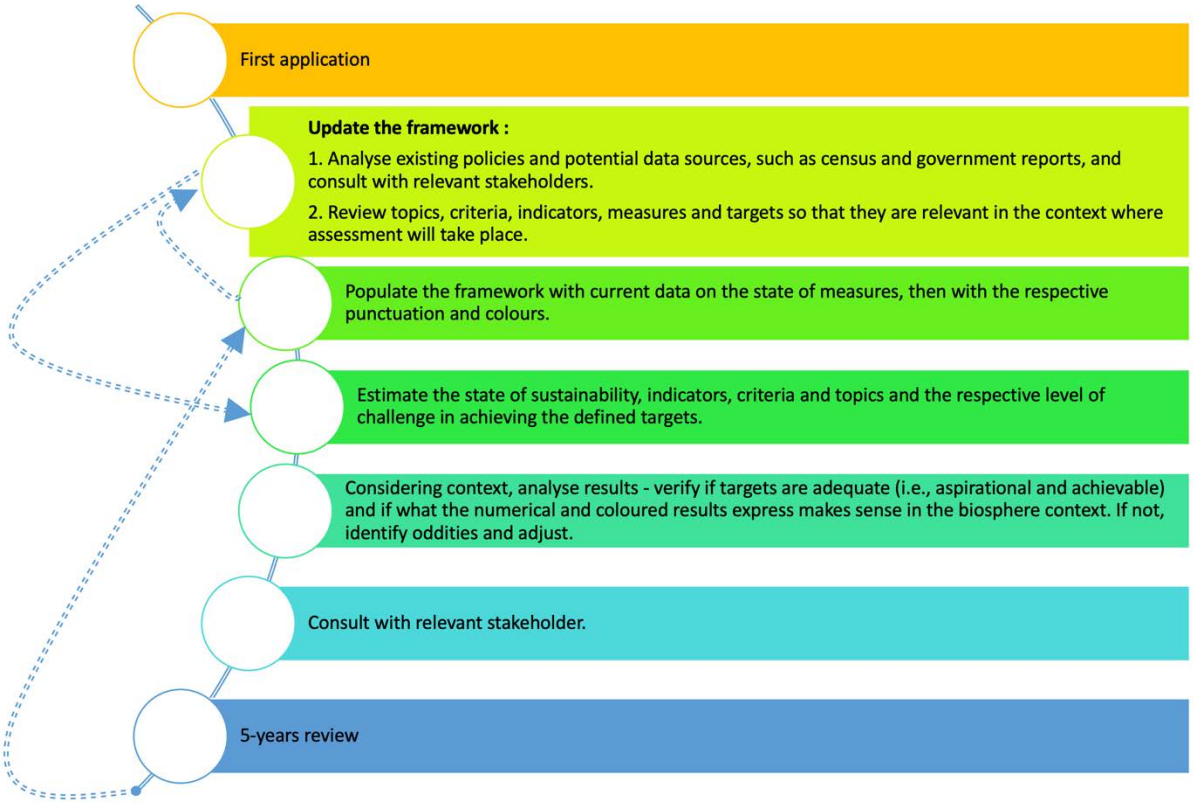

Figure 4: Steps for assessing sustainability

While the process is standard, there is no readily available mechanism to analyse the data, especially considering that the metrics used to assess the condition of different measures are different, hence, cannot be directly added. For example, emission of greenhouse gases is measured (among others) by tonnes of carbon dioxide per year, while conservation is measured by percentage of area legally protected. As adding tCO2 to KM2 is obviously not meaningful, an alternative approach is necessary.

One possibility is to consider, not the absolute state of measures, but the direction of changes (when assessing the baseline condition) or the level of accomplishment (when reviewing the situation). Then, we can assume that that the condition of indicators can be assessed based on the average of measures, the condition of criteria based on the average of indicators and so on (Box 3).

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Measures

Baseline condition ≍ direction of change

If the condition of the measure is

- moving away from the established target, then Measure = -1
- stable or slightly moving forward, then Measure = 0
- moving towards the established target, then Measure = +0.5
- at the target state, then Measure = +1

Review ≍ Degree of accomplishment ≍ $\frac{\text{(review condition – baseline condition)}}{\text{(target condition – baseline condition)}}$

Indicators ≍ $(\text{Measure}_1 + ... + \text{Measure}_n)/n$

Criteria ≍ $(\text{Indicator}_1 + ... + \text{Indicator}_n)/n$

Topics ≍ $(\text{Criteria}_1 + ... + \text{Criteria}_n)/n$

Sustainability ≍ (Society + Economy + Natural Resources + Governance)/4

Where **n** stands for the number of measures, indicators or criteria, depending on what is being measured.

Box 1: Assessment of measures, indicators, criteria, topics and sustainability

Using this assessment scheme, the sustainability level of Biospheres could potentially vary between -1 and +1. While so, it is unlikely that development in a Biosphere is radically moving away from sustainability (because, if it were, the Biosphere would be unnominated) or that sustainability has been reached (because sustainability is here understood as a direction and not a destination). As such, one could expect baseline conditions to be assessed between -0.5 and +0.5; baseline assessments above +0.5 would indicate the need for careful revision of measures, indicators and or criteria that are locally relevant in the context of – global - sustainability, even if this requires including measures from outside the boundaries of the assessed Biosphere.

Testing the algorithm

The algorithm was tested using the data previously collected for the Sunshine Coast Biosphere. The calculation of the baseline condition considered the 15 criteria, 35 indicators and 67 measures for which there was readily available and reliable data. Detailed information on the rationale behind each target, measure and indicator used in this assessment, and the populated framework are available in Attachments 2 and 3. Figure 7 synthesises the results found. Sustainability scored +0.24, which indicates the Sunshine Coast is progressing towards sustainability. This score is in accordance with the region's motto (to be Australia's most sustainable region), and with the local Council's initiatives, including the nomination of the region as a Biosphere.

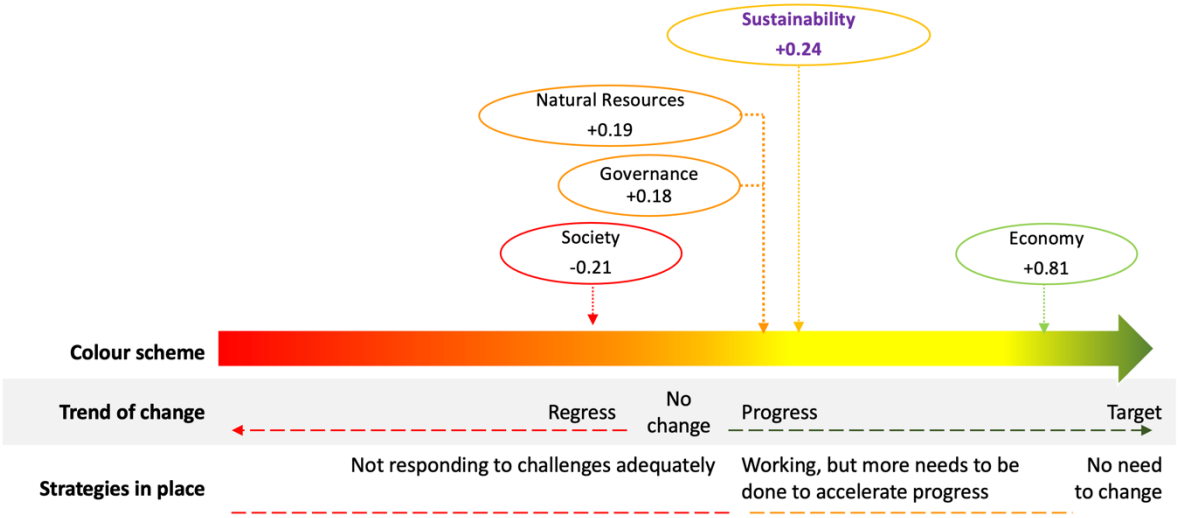

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Figure 5: The case study – current condition and level of challenge per topic and general

The analysis and its graphical representation (Figure 7) allow concluding that economy is the topic in better condition and facing the lower level of challenge in the context of sustainability. Within this topic, many of the established targets have been reached or, at least, measures are progressing towards them. As measures and targets reflect the pre-existing and currently in place economic strategy of the region, the high result (+0.81) does not necessarily mean humble targets but that current strategies are working. While so, a quick look at the economy session of the populated framework (lines 84 to 113) makes it obvious that the key problem with the local economy is the (un)fair distribution of wealth, which seems to be following the same trend as most of the world, in which very few are accumulating most of the wealth. In this context, then, from this exercise we can learn that efforts should be focused on better distributing wealth.

Society is on the opposite side of the scale. It punctuated -0.21, suggesting the condition of the local community is moving away from sustainability, that strategies in place need to be reconsidered and that it will be challenging (but not impossible) to achieve related targets in the proposed timeframe. This result largely reflects the effects of the pandemic, when, in one hand, an unexpected influx of people moved into the region causing a housing crisis, which increased the cost of living and poverty and, in the other, affected education and people's health and wellbeing. The result (-0.21) indicates that society needs to be the key focus of the Biosphere management, which will need new and ambitious plans to help on solving the current housing conundrum.

Natural resources and governance punctuated +0.18 and +0.19 respectively, which means they are progressing towards sustainability. These reflect the local reality of intense, careful, detailed and participative planning focused in accomplishing the region's motto. While the results are on the positive side, the coloured framework makes it evident that improvements are needed in all areas within the governance and natural resources topics, including increasing the protection of natural resources, lessening their use and improving their disposal, accelerating the process of adaption to climate change and of building stronger connections and a solider image.

Discussion and conclusion

The empirical test of the tool (i.e., the algorithm, the process and the framework) called attention to three aspects that deserve further consideration. First, the definition of sustainability and the related framework, which encompasses 186 factors in total. While robust, it is important to consider that each of the 700 Biospheres have their own goals (as established in the nomination processes) and idiosyncrasies, as such, there is not, and should not be, a single set of measures that can be used to perfectly gauge sustainability in all Biospheres, not even if we only consider those located in prosperous countries. The factors included in the framework, then, should be interpreted as just a starting point for a participative process of discussion with relevant stakeholders, and a common denominator to compare the effectiveness of different approaches or over time. New factors should be included to address local characteristics, and factors that are not relevant in the local context should be excluded, along with measures for which there are no data.

The exclusion of locally relevant factors for which there are no data means that important elements will not be assessed directly and quantitatively. While so, (1) qualitative analysis is still possible; (2) their listing in the framework means they, at least, are considered every five-years – which increases the chances of future monitoring and data - ; and, (3) as all factors are interconnected within the sustainability context, their conditions are likely to be reflected on the factors that are measured. Additionally, while topics, criteria and indicators are broadly stated within the framework, measures are locally defined, which maximises data availability.

Added to these exclusions, other point that deserves consideration is the fact that the framework, as designed for the Sunshine coast Biosphere, disregards impacts caused by the local community outside the borders of the Biosphere, which is especially important in the context of SDG 12, which aims at responsible production and consumption. Production's impacts at the Biosphere level can be measured based on the quality of natural resources, consumption of resources (e.g., water and energy), disposal of waste, and local working conditions; while consumption can, at this stage and at this locality, only be measured through volume of waste. While so, most of what is consumed in the Sunshine Coast and in most (if not all) Biospheres located in prosperous countries is produced elsewhere, usually in less prosperous countries and frequently in conditions that tolerate slavery, poverty, destruction of ecosystems and emission of greenhouse gases.

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Although these impacts should be considered in the framework, this information is unlikely to be available in a foreseeable future, especially if the whole production chain is observed (as it should). In the absence of such data, within the framework, external impacts are constrained to volume of waste - the logic being, the less waste, the lesser the impact of consumption. Whilst not portraying the whole picture, strict targets for disposal can, to an extent, compensate this geographical limitation.

The matter of assessment comprises the third aspect that deserves further consideration. The tool was developed to adapt to inclusions and exclusions and to base assessments on trends, instead of absolute values, which is in accordance with the fluid definition of sustainability here adopted, based on which, sustainability refers to continuous improvement. In the case study, this was especially interesting for the indicator 'life expectancy at birth', for which the related target is to be longer than the State and the country. This target has already been met in the Sunshine Coast, in fact, the Biosphere has one of the longest life expectancies in the world, yet, due to the SARS-CoV-2 pandemic, it may drop. Hence, within this assessment, it was given a -1 punctuation and it was highlighted with red, coinciding with the challenges ahead.

As assessment of the case study was based on about one hundred factors, the colour scheme made it easy to identify the areas that need attention, while the punctuation system allowed making sense of the whole and of progress in a numerical way that can be used for future comparisons; it also allows measuring the effort necessary for advancing towards sustainability.

Within its boundaries, the tool here presented has shown to provide an objective way to measure progress in Biospheres located in prosperous countries that allows for concrete comparison overtime, as well as between Biospheres and between different approaches. These comparisons are fundamental for learning how to develop a sustainable world – the key goal of Biospheres.

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