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United Nations Framework Classification for Resources and the United Nations Resources Management System guidelines and best practices for the delivery of the Sustainable Development Goals and support to the Food-Water-Energy Nexus

Development of detailed specifications, guidelines and best practices on effective use of the United Nations Framework Classification for Resources and the United Nations Resource Management System for sustainable development: Global values, regional circumstances, priorities and needs for resource management in the age of big data and artificial intelligence

Prepared by the Sustainable Development Goals Delivery Working Group of the Expert Group on Resource Management

Summary

This document sets out the concept of and principles for building detailed specifications, and best data analysis and interpretation practices for using the United Nations Framework Classification for Resources (UNFC) and the United Nations Resource Management System (UNRMS), which is under development, for resource management. These concepts are crucial when addressing the opportunities for balanced and integrated management of resources enabled by the new paradigms in the rapidly developing capabilities of big data and artificial intelligence. These include the ability to support the desired transition from a linear to a circular economy and a more transparent and equitable distribution of benefits from resource management and use perspective. The fundamental requirement is to first attain and then future-proof the UN Sustainable Development Goals. The necessary shared global values to accomplish this task, and the determining regional circumstances, priorities and needs for delivering such an approach to resource management at the local level are likewise discussed here.

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I. The Decade of Action and progress on sustainable resource management

1. Balanced, integrated and equitable management of natural resources underpins the timely delivery of all the Sustainable Development Goals (SDGs) by 2030. Likewise, the ongoing maintenance and improvement of the SDGs after 2020, including assuring the world's collective ability to sustain this effort, has to be central in all discussions. With just ten years to go to the 2030 deadline, an ambitious global push is underway to mobilize governments, civil society, businesses and calling on all people to make their personal goal their contribution to the Global Goals. The Decade of Action (2020-2030) calls for accelerating sustainable solutions to all the world's biggest challenges – ranging from poverty and gender inequality to climate change and closing the finance gap.[1]

2. For this paper, the point of focus is sustainable consumption and production (SDG 12), and how effectively several of its targets, such as 12.1 on a 10-year framework of programmes on sustainable consumption and production; 12.5 on reducing waste generation through prevention, reduction, recycling and reuse; 12.6 on encouraging companies to adopt sustainable practices and to integrate sustainability information into their reporting cycle; and 12.8 on information and awareness for sustainable development and lifestyles in harmony with nature, could be achieved before 2030. SDG 12 promotes use efficiency of resources and energy, adequate infrastructure, and universal access to essential services, resulting in green and decent jobs, shared prosperity and a better quality of life for all. Its implementation is fundamental to achieving overall development plans, reducing future economic, environmental and social costs while strengthening economic competitiveness and reducing poverty. SDG 12 has essential linkages with other goals, especially SDG 6 on clean water, SDG 7 on affordable and clean energy, SDG 9 on industry, innovation and infrastructure and SD 13 on climate action. But the fact that all the SDGs have a crucial linkage to sustainable resource management is one of the core principles on which development of the UN Resource Management System (UNRMS), to complement the United Nations Framework Classification for Resources (UNFC), is premised.

3. Restated, the core principle of development of UNRMS is: as the achievement of all the SDGs will depend on resource management, a purpose-built system is needed to drive information and support decision-making on resource development in alignment with the SDGs. UNRMS will be fit for this purpose and in being so, will represent a substantial leap from resource management frameworks in use today. UNRMS will be built with a systems view, informed by the science of complexity and non-linear processes. Moreover, UNRMS will be designed to evolve alongside rapid technological advancements in real-time global monitoring, big data, artificial intelligence (AI), and other enablers.

A. Principles, measurement and management

4. It is natural to question the rationale behind the emphasis on principles more than specifications for UNRMS at this time. One reason is that if the principles are not understood and agreed upon, the new paradigms that are sought for resource management will not be clearly defined, and hence neither measurable nor manageable. Useful and functional specifications critically depend on clear and simple principles.

5. This relationship between measurement and principles is not new. One of the purposes of defining principles is to clarify the methods needed for measurement. Another purpose of the principles is to aid in analyzing and using data produced. Lord Kelvin's celebrated lecture to the Institution of Civil Engineers on Electrical Units of Measurement, 3 May 1883, is frequently cited for its emphasis on measurement as the first requisite for management. However, what is being measured and why it has to be measured is less discussed:

> "In physical science the first essential step in the direction of learning any subject ***is*** to find **principles of numerical reckoning** and practicable methods for ***measuring*** some quality connected with it. […] many of the greatest advances that

[1] UN Decade of Action https://www.un.org/sustainabledevelopment/decade-of-action/

have been made since the beginning of the world to the present time have been made in the earnest desire to turn the knowledge of the properties of matter to some purpose useful to mankind".

6. Therefore, the stress on "principles of numerical reckoning" and the act of measurement for "some purpose useful to mankind" are worth considering.

7. SDG 12 defines the purpose of UNRMS, which is sustainable resource management. This purpose requires proving the principles that must be applied to create transformative methods for measuring and managing the world's resources in the service of sustainable development across the generations. The compelling purpose is both to enhance resource efficiency but also to eliminate all avoidable losses and waste entailed in "conventional" methods of primary resource recovery and processing. The purpose also includes eliminating long-lived negative externalities that have for so long been assumed to be a necessary consequence of the linear approach to resource management. Acquiring useful data and making it available on the fly to those needed is crucial in many situations, especially when climate change-related disruptions could play havoc with traditional situations.

8. A rich and still rapidly developing array of new tools and techniques for capturing and analyzing data and making measurements of resources across their predicted life cycles is now available. These tools are relevant, whether for sampling and characterizing the resources through new forms of instrumentation or platforms such as satellite imaging or making sense of what the vast quantities of data tell us. These tools are ideally built with a mix of technologies such as cloud computing, big data, AI, and enable us to strip out meaningful "signals" from vast amounts of "noise".

9. In the past few years, these capabilities have been very powerfully applied to better understanding and hence mitigating chronic stresses on vital resources the world depends on for meeting basic needs, notably Food, Energy and Water (FEW). These stresses are now recognized to be interdependent, leading to a focus on the so-called FEW nexus. Sustainable management of this resource nexus is seen as one of the paradigms which UNRMS has to service.

B. Charting the new normal with 21st Century tools and technology

10. Attaining a "new normal" state for balanced, integrated resource management requires new tools to serve new paradigms. Such tools will have to help transcend several cognitive fallacies that arise from short-term vision. The short-term vision is usually measured in a market-sense by the over-dependence on quarterly market performance as the one-dimensional performance measure. A transcendence is, however difficult due to the limitations of the human brain, which has evolved over a few million years to react to situations that are vastly different from what is faced today.

11. With the processing power now available, which hampered the adoption of previous cycles of AI development, AI offers the promise of complementing the human brain, and at the same time overcoming its cognitive constraints. AI is notable in how it can be used to capture and accurately interpret high volumes of complex data. A compelling example of how this works was published in Nature in January 2020,[2] showing "the artificial intelligence algorithm outperformed both the historical decisions made by the radiologists who initially assessed the mammograms and the decisions of six expert radiologists who interpreted 500 randomly selected cases. The algorithm also reduced the proportion of screening errors – where the cancer was either incorrectly identified or where it may have been missed".

12. The AI-based neural network approach or similar machine learning is being reinforced with complementary technologies such as blockchain, virtual reality, augmented reality and Internet of Things (IoT). These tools will speed the further efficiency and accuracy of screening and diagnostic procedures for both chronic diseases such as cancers, and acute

[2] See Artificial intelligence could help to detect breast cancer https://www.nihr.ac.uk/news/artificial-intelligence-could-help-to-detect-breast-cancer/23492

seasonal diseases such as influenza, while in parallel aiding more rapid drug development and testing and more personalized treatment. The first influenza vaccine created entirely by AI was reported in July 2019.[3] Other efforts worthy of mention are OneGeology.org and similar work in other earth-science domains like remote-sensing and water, the standardizers that will enable the tools of AI and big data. While it could be true that the currently available AI will not be able to replace the human brain, the effective deployment of AI makes specific tasks more efficient and less error-prone. Once such AI-enabled decision-making systems are available more widely, alternate pathways to sustainable development will begin to emerge.

13. However, the development of AI is only now coming out of its infancy. Current systems all fall in the realm of Artificial Narrow Intelligence (ANI), which can just play out a particular undertaking independently utilizing human-like capacities. This will, however, quickly progress to the development of Artificial General Intelligence (AGI), where systems learn, see, comprehend, and work totally as a person. Artificial Superintelligence (ASI) will be enabled in the future when systems acquire more prominent memory, quicker information handling and examination, and leadership abilities.

14. Currently, AI is being employed in self-driving cars, digital assistants, translation, facial recognition and medicine. AI is playing a significant role in understanding the genome of SARS-CoV-2, the virus that causes COVID-19 disease, understanding its mutations, and developing vaccines and anti-viral drugs. AI is also now employed in oil and gas exploration, especially in the interpretation of 3D seismic data and to increase the productivity of oil wells.[4] Use of AI in renewable energy production is another exciting development.

C. Chronic and acute resource stress

15. An example of the way big data will interact with and benefit from UNRMS for addressing critical chronic resource stress is research published in September 2019. The study in question was on using the latest satellite imaging technology to map the extent of salinization and desertification of soils worldwide.[5] This is the first time that an accurate assessment has been undertaken on a global scale, even though it has been long recognized as a critical issue. The outcome is that at least 1 billion hectares are affected by salinization. These figures translate to an estimated annual loss per hectare of USD 961. In aggregate, USD 1 trillion per year is lost in monetary value to farmers and landowners. The related losses to consumers from the resulting yield gap can be quantified in measurable tonnages of food and cubic metres of water efficiency loss, just from that one problem of degraded soil. There are no equivalent calculations for assessing the economics of desertification losses, but data from the Food and Agriculture Organization (FAO)-UN Environment Programme (UNEP) indicate annual top-soil loss of an estimated 25 billion tonnes. A new paradigm of how to manage the world's soils as a critical resource within the FEW nexus is urgently needed.

16. Since 2019, the emphasis on chronic stress has suddenly been complemented by acute stress in the shape of widespread forest fires and the COVID-19 pandemic. Such crises have a significant and immediate bearing on how resources are produced, distributed and consumed, revealing significant stresses on supply chains and the industries they serve when the personnel that service them get sick or incapacitated. While such extreme events are difficult to predict by traditional methods, with the help of AI tools[6] the need can be defined

[3] See Human Vaccine Created Solely by Artificial Intelligence https://www.docwirenews.com/docwire-pick/human-vaccine-created-solely-by-artificial-intelligence/

[4] Rahmanifard, H and Plaksina, T (2018) Application of artificial intelligence techniques in the petroleum industry: a review, Artificial Intelligence Review 52(5).

[5] Yadav R.K., Datta A., Dagar J.C. 2019. Future Research Needs: Way Forward for Combating Salinity in Climate Change Scenario. In: Dagar J., Yadav R., Sharma P. (eds) Research Developments in Saline Agriculture. Springer, Singapore.

[6] Coronavirus: NHS uses tech giants to plan crisis response https://www.bbc.co.uk/news/technology-52053565

for a new paradigm of managing stretched human and technical resources during complex acute events. This paradigm enhances efficiency in our immediate responses but also offers the prospect of better enabling us to limit the exposure to such events in future through better planning and preparedness.

17. Apart from the human costs, all industries, including the critical FEW nexus-related resource sectors, are being impacted by the economic consequences of these most extreme of Black Swan events. Not only does this focus stakeholder attention on SDG 3 related to good health and wellbeing, but the need in parallel to achieve a better understanding of how sustainable resource management can offer a better basis for in future preventing infectious diseases from spreading. Such prevention could include support to a clean and healthy environment or better managing movements of people and resources in the global economy. A new paradigm is essential for managing human and technical resources for preserving and enhancing public health, especially in its ability to respond to acute and unpredicted crises, based perhaps or redefining what public health as a term means.

D. More than the sum of their parts

18. Methods of valorizing and using natural resources create complex local, regional or even planetary systems, composed of many components interacting with each other in widely varying ways. The structures of such systems can be decomposed into their components and underlying processes. Complexity in such a context does not refer to the properties of the individual components within such systems and sub-systems. Instead, it is the relationships between these components and the complex behaviours they exhibit, whether in the natural world or engineered systems. Both types of system are intrinsically challenging to understand. The issue is due to the dependencies, competitions, bonds, or different types of interactions between their parts or between a given system and its environment. Complex systems are more than the sum of their parts.

19. Complex systems have distinct qualities that arise from these relationships, and, as Lord Kelvin realized, the role of measurement is to understand what these systemic qualities are and how they can be managed. These include concepts such as nonlinearity, emergence, self-organization, adaptation, and feedback loops. The nonlinearity of a complex system means it may respond in different ways to the same input depending on its state or context. The “butterfly effect” is a common metaphor – the beating wings of a butterfly can release forces that cause a catastrophic storm half-way across the globe.

20. One quality of places where resource intensity is very high in terms of both production and consumption, such as large cities, is that chronic and acute stress may both be equally observed in the natural and the engineered systems which characterize them. This quality is a crucial indicator that they can give rise to catastrophic public health events. Some examples are the acute events such as the COVID-19 in Wuhan, the People’s Republic of China, and the chronic events such as the outbreak of HIV-AIDS, origins of which can be traced back to the 1920s in Kinshasa, Democratic Republic of Congo, then a Belgian colony, with its economy based on mining. Common attributes of such places are high levels of population density, connectivity, biodiversity hotspots, waste and air pollution.

21. As UNFC has evolved its areas of application have expanded from natural resources such as coal, petroleum, and minerals to encompass renewables and more recently anthropogenic resources and groundwater. UNFC has moved into complexity and into linking the “natural” world of reservoirs and deposits with engineered systems like cities. This is a reality which drives this quantum leap in thinking: there is no division between nature and civilization anymore (there never was) in terms of resource management. This seems obvious but will be a paradigm shift for resource managers and city or engineered system managers alike. “Externalities” are placeholders for system coupling-points.

22. The negative externalities such places may generate can be both tangible and intangible and have both chronic and acute consequences. Legacy tailings and residues from mining and processing of minerals such as bauxite, copper, gold, iron phosphate and uranium leave expensive, lasting impacts not least from the sterilization of land used to store them. By contrast, catastrophic events such as the two tailings dam failures in Brazil cause acute

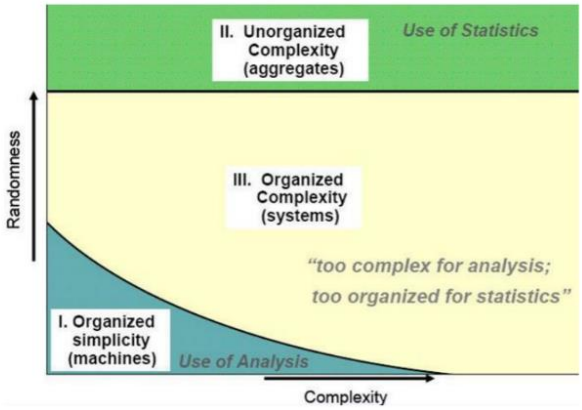
damage when they occur including significant loss of life, while also creating major chronic externalities affecting both public and environmental health and safety. The former Chief Executive of BP characterized the Deepwater Horizon disaster in the Gulf of Mexico as a "near-death experience" for BP as a company. At the same time, the explosion itself claimed 11 lives and injured 17 more. The inquiry into the causes concluded that it had deep "systemic" causes which are an attribute that defines most such catastrophic failures such that we know now that it is no longer a question of if they will occur, but when.

23. All this has forced a deep reset for the culture and values of resource recovery and management companies which have realized that the new non-negotiable operating imperatives are zero waste and zero harm. Fortunately, these same two principles are at the heart of the process of transitioning towards circular economic models, a process it can be anticipated that the COVID-19 pandemic will further accelerate.

E. Black Swans

24. Black Swans are unpredicted, though perhaps not unpredictable, events to which we are systemically vulnerable. Such events arise from a mixture of our inability to predict the future and to retain resilience based on lessons learned from similar past experiences.[7] In systems thinking, the likelihood is that a Black Swan will emerge from the type of complexity that falls between the two extremes of organized simplicity and unorganized complexity (see Figure I). The middle region of "organized complexity" may be defined as "too complex for analysis and too organized for statistics".[8]

Figure I
Complexity versus randomness model showing the region where systems lie



25. Black Swans and system collapses can occur very quickly in complex systems, often due to the power-laws that govern them. But in some systems like earth-resource systems, time scales can be longer than human memory, and Black Swans emerge so slowly that they are just perceived as normal to current lives but would be abhorrent to people in the past were they to experience these conditions. The larger time-scale events are in fact scaled-up versions of the small-scale events.

26. While it is true that analytical methods or statistical techniques could manage some of the natural resource management issues, many of the critical areas such as waste and environmental management, safety and market mechanisms are dominated by organized complexities, which makes their understanding very difficult. Hindsight bias often dominates our epistemology related to natural resources. Having a clear insight on these issues requires a long-term view of the system, which some stakeholders are naturally attuned to have. Other stakeholders, mostly the operational units of industry, have a short-term perspective, arguing that focus on the immediate task in hand is essential for effective day-to-day operations. But systemic failure typically has its roots in a degree of emphasis on the short-term view rather

[7] Taleb, N (2007) The Black Swan: The Impact of the Highly Improbable, Random House
[8] Weinberg, G (2011) An Introduction to General Systems Thinking, Weinberg & Weinberg

than long-term factors, which are equally critical to system stability, either benignly neglected or consciously excluded from management attention.

27. Failing to see beyond the immediate is also reflected in the related actions and decision-making of many stakeholders. A mining or petroleum company will rarely see COVID-19 or similar pandemics as a mining or petroleum industry issue. The usual response is that being a medical problem, it could be better left to organizations that have competency in handling the situation. However, there are increasing numbers of companies in the resources sector that recognize such attitudes put the whole business at risk, leading to a total breakdown of the social licence to operate.

28. Fixed mindsets are grounded in the purely rational view that says you can have either A OR B outcome, but not both. This so-called "tyranny of the OR," in the field of managing critical resources yields a zero-sum economic outcome where the costs of dealing with negative externalities equal or exceeds all aggregated profits. This problem, which has its origin in linear production models, which regard waste as just a cost of doing business, demand a high cost at 'End of Life' of a given project. However, because sometimes no provision was made for covering such a cost, the end game played was that the operator simply ceased business and left the "ownership" of the externality with the communities left behind or with the State.

29. The "genius of AND" is the alternative win-win strategy, the belief that allows resource management to pursue both A AND B outcomes at the same time.[9] Accommodating resource management to this principle is fundamental to development of UNRMS.

F. The rise of stakeholder capitalism

30. In 2019, partly in response to such systemic failures, major corporations led in some aspects from the financial community itself, began to commit publicly to stakeholder capitalism. They are abandoning a long-influential economic principle that the markets must be allowed to perform their role while the duty of boards of directors was to focus solely on enhancing shareholder value. Including other stakeholders, such as the workforce, the supply chain, the value chain, communities, whether through health and wellbeing or financial benefit or both is of course not new.

31. Many companies were formed in the industrial revolution by "enlightened capitalists" whose benevolent values, born overtly of self-interest, still, endure in the companies they founded. These companies were already practicing the principles of stakeholder capitalism two centuries ago. And it is perhaps no accident that these companies are among the few big corporations that have proved resilient in the long-term and have consistently outperformed general stock indices. While there are criticisms that such moves will divert companies from their core purpose, i.e., to make profits, stakeholder capitalism is not a zero-sum game with "either this OR that" thinking. Companies are today seeing the value of this approach and hope that the stakeholder focus could help them diversify and become more profitable.

32. Taking the stakeholder capitalism route promises to make the companies that adopt it better prepared for the Black Swan events. And while it seems unlikely that they may be able to predict such events with any level of accuracy, recognizing that the next one is never far away may help companies and governments. They can have an effective way to be ready and resilient. And being prepared means making oneself less vulnerable to unforeseen acts of nature. The 2030 Agenda for Sustainable Development is itself a roadmap to build this kind of resilience and increase profitability and relevance. The refrain of "integrated and indivisible" urges all stakeholders to break silos and open up new sustainable development pathways.

[9] Collins, Jim (2004) Built to Last: Successful Habits of Visionary Companies, Harper Business.

G. Enabling sustainable resource management

33. UNFC had its origins in the aftermath of World War II when the challenge was rebuilding Europe's economy after the devastating damage caused by the war. Energy was identified as one of the primary needs, which at that point meant coal (coal was also needed for manufacturing steel), so a standard was born from a need to classify and quantify available coal resources, which went on to evolve as UNFC in 1997. The first step-change in the scope of application of UNFC happened in 2004 when its reach was extended from minerals to the primary alternative energy sources, oil and gas. In the wake of that change, the respective classifications used by the minerals and oil and gas sectors were retained at the industrial level and then bridged to UNFC.

34. UNFC was significantly updated during the period from 2009 to 2019. Rapid progress was made to cover an ever-wider set of resource categories including nuclear energy, renewable energy and injection projects. Then a second step-change came with the adoption of anthropogenic resources. More recently groundwater resources are an area of focus. This progress has led to significant growth in attendance at the annual meetings of the United Nations Economic Commission for Europe (ECE) Expert Group on Resource Management and a noticeable upturn in the use of UNFC by government entities around the world. Social and environmental guidelines were also incorporated into the progressively revised framework. The structure, definitions and terminology of UNFC were updated in 2019 to facilitate seamless and consistent use of UNFC across resource sectors.

35. Given the speed of change in expanding the scope of application of UNFC, it is not surprising that usage remains siloed. Each different resource sector works currently under separate specifications. Moving forward, in the quest to make "integrated and indivisible" resource management as called for by the 2030 Agenda a reality, UNRMS is being developed to bridge across all resources so as to provide a tool-kit for integrated resource management.

36. As UNFC and UNRMS evolve to meet this need, consideration will also have to be given as to how to best negotiate a strategy for transforming the still widely held "commodity mindset" of the resource management community. Even though most stakeholders have realized the importance of extracting themselves from the "tyranny of OR", centuries-old business practices continue. Stakeholders cannot be blamed as this is the familiar destination to which most rational actions will take them. It is becoming ever more apparent that measurement concepts such as "reserves" and "reserve replacement ratio" are becoming increasingly less relevant as the new stakeholder-centred business model takes hold and awareness of the true costs of negative externalities grow.

37. The ongoing shift of interest away from resource classification and quantification throughout the world in the last decade or so stems from the tightening up of resource/reserve reporting in financial markets and exchanges. Another reason is the ability of geologists and engineers in the resource sectors to find and produce ever-greater volumes of resources at ever-falling direct costs. The fear of shortages of the past have given way today to a complacency of resource surplus. In place of these fears there is increasing interest in socio-environmental external costs and governance of the flow-through of wealth and benefits from development (both of which have become disconnected from the geography of extraction). These shifts of emphasis in resource management underline why UNRMS is needed.

38. Meanwhile, alternative models centred on the emerging circular economy framework are not yet mature, so solutions for making the transition from linear to circular are neither easy to conceive nor to put into practice. For this reason, the circularity "gap" remains high.[10] Climate change though is recognized as a grave threat, and decarbonization as a primary objective. In spite of short-term reductions in greenhouse gas emissions resulting from the drastic COVID-19 economic downturn, the world is on a trajectory for a 4-6˚C rise in temperature by 2100.

[10] See Circle Economy (2020) The Circularity Gap Report 2020 https://assets.website-files.com/5e185aa4d27bcf348400ed82/5e26ead616b6d1d157ff4293_20200120%20-%20CGR%20Global%20-%20Report%20web%20single%20page%20-%20210x297mm%20-%20compressed.pdf

H. Accelerating the drive towards the circular economy, resilience with a future-proofed model

39. It is now evident that the unhindered production and consumption patterns of natural resources will not be an option for the future. Even though the importance of the circular economy has been recognized for a long time, application has been successful only in specific limited contexts. Cutting down on waste and reducing carbon emissions should be the basis for resource use. If this is not achievable within a reasonable time frame, the future of the planet will be in jeopardy.

40. It could prove that circular economy action will be difficult to achieve with a linear economy framework. All current systems, models, standards and best practices were devised to support a linear economy process. Moving from the present situation to a circular economy may not be achievable if a clear path for repurposing the current system is not found.

41. The redesign requires a careful analysis of needs and gaps of the circular economy and enabling of the systems to deliver on the requirements of a circular economy. Having a teleological approach of assigning purposes for different elements in a system is not ideal. An empirical evidence-based approach to structural transformation balanced with a deterministic set of core principles needs to be evolved. The Stockholm Resilience Centre has identified planetary boundaries within which humanity can continue to develop and thrive for generations to come. The boundaries include stratospheric ozone depletion, loss of biosphere integrity, chemical pollution, climate change, ocean acidification, freshwater consumption, land system change, nitrogen and phosphorus flow to the biosphere and oceans, atmospheric aerosol loading.[11] Crossing these boundaries increases the risk of generating large-scale abrupt or irreversible environmental changes.

42. Such evidence-based approaches will increase the resilience of the system, in the sense that the system will be capable of delivering on the planned pathway towards circularity and facing Black Swan events more effectively. The current COVID-19 situation amply proves that this can be done, as seen from various examples of manufacturing facilities being repurposed within a short time to supply anything from hand sanitizers[12] and medical masks[13] to ventilators.[14]

43. Future-proofing in the current context of elevated uncertainties due to climate change and population explosion means looking for interconnectedness that previously did not exist or was not apparent. AI will be useful in discovering these new connections. AI could do this faster, without the process of stumbling upon a solution by accident. The standard approach of slow incremental progress could work in most situations. But for a world that is seeking a massive transformation, or when multiple crises such as climate change, widespread fires and the COVID-19 pandemic happen in parallel, we need to seek innovative, AI-enabled approaches.

I. Global Principles for resource management

44. If the objectives of the 2030 Agenda are to be achieved in time, and at a reasonable cost, then there has to be a change in the fundamental principles we use to manage resources. The core principles also need to be associative. They should connect to all sectors of

[11] See Stockholm Resilience Centre “The Planetary Boundaries” https://www.stockholmresilience.org/research/planetary-boundaries/planetary-boundaries/about-the-research/the-nine-planetary-boundaries.html

[12] See “Luxury perfume makers Dior and Givenchy will produce free hand sanitizer for French health authorities” https://edition.cnn.com/2020/03/15/business/coronavirus-lvmh-dior-hand-sanitizer-trnd/index.html

[13] See “In the face of an N95 mask shortage for coronavirus healthcare workers, sewists got to work” https://fortune.com/2020/03/23/n95-mask-shortage-coronavirus-sewists-seamstresses/

[14] See “GM, Tesla tackle ventilator shortage amid coronavirus pandemic” https://eu.usatoday.com/story/money/cars/2020/03/22/coronavirus-ventilator-shortage-gm-tesla-covid-19/2895190001/

development and the ecosystem by weaving a network of activities that lead to beneficial outcomes for people, planet and prosperity. The links of resource management should always be underpinned by the Food-Water-Energy (FEW) nexus. The provisional list of UNRMS principles are provided for comment, and subsequent consolidation in the document "United Nations Resource Management System Concept Note: Objectives, requirements, outline and way forward" (ECE/ENERGY/GE.3/2020/4).

45. For the circular economy to be realized principles are not enough, countries must also share data and align industrial policies and trade to shared outcomes as expressed in the SDGs. A global database[15] based on UNRMS principles needs to be set up to capture links between resource uses, and a global platform established for sharing knowledge. International partnerships are needed to promote large-scale experimentation and development of UNRMS specifications for performance measurement, reporting and accounting.

J. Regional circumstances and priorities

46. Regional and national tailoring to needs is a prerequisite for sustainable resource management. For example, the European Union (EU) emphasizes strategic considerations and new, more sustainable resource provision paradigms. The EU made €80 billion funding available to innovation through the "Horizon 2020" programme 2014-2020, and a further €100 billion will be available for 2021-2027 through the proposed "Horizon Europe" programme. As shown by the size of investment in these programmes, research and innovation are central to the EU's raw material strategy. UNFC is being applied for management of critical raw material resources in Europe.[16] In the Russian Federation, financing resource projects in a conventional, market-driven manner could be a challenge, as this sector is viewed as a high-risk industry, so alternative financing mechanisms are being actively sought.[17] Other countries in Central Asia and South-East Europe follow similar integrated approaches.[18]

47. In Asia, resource scarcity contrasts with growing demand. Resource demand in both China and India is not matched by domestic availability, requiring both countries to adopt a three-pronged approach to security of supply: (i) increasing primary production, (ii) exploring secondary production from unconventional resources and (iii) seeking global access. UNFC supports the progress towards data harmonization in China[19] and India.[20]

48. Africa provides another extreme of various pressures at play. Maximizing revenues with little regard for a better fiscal regime has plagued the region for a long time. Many countries in the region stand out for their lack of policies in resource management and still depend on negotiating development contracts on a case by case basis. With the lack of negotiating and contract writing experience, many countries stand in a weak position vis à

[15] See Yong Geng, Joseph Sarkis and Raimund Bleischwitz (2019) Globalize the circular economy, Nature, V565, pp 153-155.

[16] See UN Framework Classification helps EU to manage raw materials for batteries and shift to circular economy http://www.unece.org/info/media/news/sustainable-energy/2019/un-framework-classification-helps-eu-to-manage-raw-materials-for-batteries-and-shift-to-circular-economy/doc.html

[17] See UNFC to help drive smart investments into mineral and energy projects https://www.unece.org/info/media/news/sustainable-energy/2018/unfc-to-help-drive-smart-investments-into-mineral-and-energy-projects/doc.html

[18] See UNECE helps improve data integration for sustainable energy and water resource management in South-East Europe and Central Asia https://www.unece.org/info/media/news/sustainable-energy/2019/unece-helps-improve-data-integration-for-sustainable-energy-and-water-resource-management-in-south-east-europe-and-central-asia/doc.html

[19] See China bridges its mineral and petroleum resource classification systems to UNFC https://www.unece.org/info/media/presscurrent-press-h/sustainable-energy/2018/china-bridges-its-mineral-and-petroleum-resource-classification-systems-to-unfc/doc.html

[20] See UNFC is Key to Sustainable Development in India http://www.unece.org/info/media/presscurrent-press-h/sustainable-energy/2013/unfc-is-key-to-sustainable-development-in-india/unfc-is-key-to-sustainable-development-in-india.html

vis the commercial operator or investor. Hence the first contract settled, however unfair or flawed it may be, becomes the template for all subsequent agreements. Former UN Secretary-General Kofi Annan pointed out the scale of revenue loss in Africa caused by this weakness, which if plugged, could make Africa effectively non-aid dependent. Led by the African Mining Vision, a UNFC and UNRMS-based African Mineral and Energy Resources Classification and Management System (AMREC) is being developed by the African Union.[21]

49. The Americas, blessed with abundant natural resources, has issues of indigenous populations or the First Nations at play.[22] Rich culture, often captured in the timelessness of monuments and archaeological sites, is an area of intersection with resource development.

50. All regions now place close attention to multiple issues specific to their neighbourhoods and their unique solutions. The European Union, the African Union, and multilateral formulations such as the BRICS (Brazil, Russian Federation, India, China and South Africa) block – now proposed to be enlarged to include Pakistan, Bangladesh, Iran, Nigeria, South Korea, Mexico, Turkey, Indonesia, the Philippines and Vietnam – are making rapid strides in tackling common issues through regional and inter-regional collaboration. It is well recognized that many of the challenges are not within the remit of individual countries to address while multilateral efforts often bear fruit.

K. The new normal

51. The opening months of 2020 could well earn a place in the history of the world as the point in time when "integrated and indivisible" development began, or perhaps was forced to begin.[23] Life and work on this planet are being reshaped as a global pandemic marches over it, with no respect for borders or border controls. Utilizing the resources of the deep sea/ocean floor/continental shelves and outer space are quickly emerging as the new frontiers of resource management. These areas will be opened in our lifetime driven by commercial ocean and space enterprises and new national space programmes. The "new" world will be increasingly AI, big data and blockchain-enabled. It will have a systems approach as its core philosophy for maintaining sustainable growth.

52. Once the principles of that system are defined, technical specifications for AI and other technology infusions as applicable to UNFC and UNRMS for the attainment of SDGs by 2030 will need to be put in place. The specifications need to be tested through pilot projects. The new International Centres of Excellence on Sustainable Resource Management (ICE-SRMs) under consideration by a number of countries and regions around the world could be the platforms on which global as well as regional needs, can interplay and support a new system that is focused on resilience.

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[21] See Africa: world leader in implementing a UNFC-based continental system for sustainable resource management https://www.unece.org/info/media/news/sustainable-energy/2019/africa-world-leader-in-implementing-a-unfc-based-continental-system-for-sustainable-resource-management/doc.html

[22] See Mexico tests use of UNFC for the assessment of petroleum projects https://www.unece.org/info/media/news/sustainable-energy/2019/mexico-tests-use-of-unfc-for-the-assessment-of-petroleum-projects/doc.html

[23] The Communique of the Emergency Summit of G20 Leaders March 26, 2020 gives a taste already of such an approach, forced by the COVID-19 pandemic.