

**UNECE**

# United Nations Resource Management System

An overview of concepts, objectives and requirements



**68**

UNECE Energy Series



**UNITED NATIONS**



UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE

# UNITED NATIONS RESOURCE MANAGEMENT SYSTEM

AN OVERVIEW OF CONCEPTS, OBJECTIVES AND REQUIREMENTS

ECE Energy Series 68



**UNITED NATIONS**

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**T**he 2030 Agenda for Sustainable Development has inaugurated a new era of global development marked by an imperative to integrate social, environmental and economic objectives. The multifaceted requirements of sustainable development depend on optimal and responsible production and use of natural resources. Today's patterns of supply and use of natural resources are unsustainable as they present challenges in terms of environmental and societal impact and long-term availability of the resources needed for sustainable development.

Over many years, the United Nations Framework Classification for Resources (UNFC) has become a unified system for the classification, accounting and reporting on activities associated with resource production based on social, environmental and economic viability, technical feasibility and degree of confidence in resource estimates. UNECE's Expert Group on Resource Management (EGRM) has developed UNFC to classify mineral resources, petroleum, nuclear fuel, renewables, anthropogenic resources, and geological storage. Detailed rules and guidelines for the use of UNFC for groundwater are under development.

In 2017, UNECE member States decided to extend UNFC beyond a system of classification to a dynamic resource management system that can help countries, organizations and companies address the challenges of sustainability. The Expert Group on Resource Management has been tasked to develop the United Nations Resource Management System (UNRMS) which will be a voluntary global standard for integrated and sustainable resource management, within the framework of public, public-private and civil society partnerships. While recognizing that resource management remains the responsibility of countries, UNRMS will provide fundamental principles of good governance that can be applied by stakeholders at different levels – national, regional and project level.

Resource production, transformation and use, properly managed, can ensure beneficial social and environmental outcomes. Broadening application of UNFC to a full-fledged management system – UNRMS – will offer a dynamic tool to align investment frameworks with sustainable development.

This publication discusses the objectives, requirements, outline and way forward for the development of UNRMS. I recommend the concepts discussed in this publication for critical review by all stakeholders concerned with sustainable management of natural resources. Engaging with us in this endeavour will help UNECE in its efforts to support countries to build back better.



**Olga ALGAYEROVA**

United Nations Under-Secretary-General  
Executive Secretary  
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## ACRONYMS AND ABBREVIATIONS

AAPG	American Association of Petroleum Geologists
AI	Artificial Intelligence
AMREC	African Mineral and Energy Resources Classification and Management System
AMV	Africa Mining Vision
ANI	Artificial Narrow Intelligence
AGI	Artificial General Intelligence
ASI	Artificial Superintelligence
AU	African Union
BRI	Belt and Road Initiative
BRICS	Brazil, Russian Federation, India, China and South Africa
CERA	Certification of Raw Materials
CIS	Commonwealth of Independent States
CRR	Comprehensive Resource Recovery
CRIRSCO	Committee for Mineral Reserves International Reporting Standards
FAO	Food and Agriculture Organization of the United Nations
FEW	Food-Water-Energy
UNECE	United Nations Economic Commission for Europe
EGRM	Expert Group on Resource Management
EGS	EuroGeoSurveys
EU	European Union
HIV/AIDS	Human Immunodeficiency Virus infection and Acquired Immune Deficiency Syndrome
IAEA	International Atomic Energy Agency
ICE-SRM	International Centre of Excellence on Sustainable Resource Management
IoT	Internet of Things
IRP	International Resource Panel
NEA	Nuclear Energy Agency of OECD
OECD	Organisation for Economic Co-operation and Development
PRMS	Petroleum Resources Management System

REE	Rare Earth Elements
SDGs	Sustainable Development Goals
SEEA	System of Environmental-Economic Accounting
SLO	Social Licence to Operate
SNA	System of National Accounts
TBL	Triple Bottom Line
UNEP	United Nations Environment Programme
UNFC	United Nations Framework Classification for Resources
UNRMS	United Nations Resource Management System

**P**olicymakers, governments officials, industry leaders, financiers, academics, researchers and the public in general have concerns on the best actions required to tackle global challenges including climate change, environmental degradation and natural resource use. Stakeholders are hampered by the lack of a common vocabulary and harmonized tools that can help them act effectively, efficiently and coherently on a host of issues related to sustainable resource management.

The utilization of natural resources has been facing increasing challenges, accelerating over the past two decades. While global warming remains a significant threat, other issues such as biodiversity loss; increasing air, water and land pollution; and mounting waste have made the situation worse. Since 2019, the global challenges have been amplified by the COVID-19 pandemic, devastating forest fires, intense droughts and floods. Such crises have an immediate and significant impact on how resources are produced, distributed and consumed, revealing substantial stresses on supply chains and the end users they serve.

Sustainable resource management faces a myriad of other challenges including market volatilities; long-term decline in productivity and fluctuation of commodity prices; persistent issues in maintaining demand and supply balance; eroding investor confidence; failure to address social and environmental impacts; geopolitical issues and conflicts.

In 2015, the 2030 Agenda on Sustainable Development (2030 Agenda) inaugurated a new era marked by a new narrative of pursuing “economic, social and environmental” gains in equal measure, with a commitment to meeting the needs of two key beneficiaries “people” and “planet” through the common goal of sustainable “prosperity” for all. In 2016, the world also committed to the Paris Agreement on Climate Action in “holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change”.

UNECE’s Expert Group on Resource Management (EGRM), in response to these challenges and to support the collective actions, has taken two significant steps. To aid global communications, EGRM has been developing, improving and supporting the implementation of the United Nations Framework Classification for Resources (UNFC), a resource classification system. UNFC now applies to mineral, petroleum, nuclear fuel, renewable energy, and anthropogenic resources, as well as geological storage. Efforts are underway to broaden the application of UNFC to encompass groundwater resources. Since 2015, UNFC has incorporated a strong emphasis on environmental-social-economic viability, including additional guidelines for applying social and environmental considerations.

In 2017, EGRM initiated development of a comprehensive system for the sustainable management of resources, now called the United Nations Resource Management System (UNRMS). UNRMS is entirely complementary to and a logical extension of UNFC, providing a toolkit for the systemic and dynamic development of resources over time and in alignment with the 2030 Agenda. With these actions, the necessary globally acceptable tools for making natural resource use sustainable and balanced will be in place for broader stakeholder uptake.

It is expected that UNRMS will be widely used by resource management stakeholders across sectors and jurisdictions. The primary stakeholders are:

- Governments/Regional bodies;
- Industry;
- Investors and financial regulators;

- Academia, Non-profits, Indigenous Communities and the Public.

Sustainable resource management is defined as the total of policies, strategies, regulations investments, operations and capabilities within the framework of public, public-private and civil society partnerships. It is based on environmental-socio-economic viability and technical feasibility, which determine what, when and how resources are developed, produced, consumed, reused and recycled by society.

The process of sustainable resource management starts from an understanding of the world's natural capital and natural resources, including the efforts required to refine and use them, and how this relates to societal needs. Natural capital is the world's stocks of natural assets. It is a concept for a plurality of connected, heterogeneous stocks that perform various functions and services for human society. Natural capital includes a variety of components such as water, geology, biodiversity, soil, the atmosphere and properties including ecological resilience, ecosystem health and integrity.

Resource management decisions have historically been made on a project-by-project or sector-by-sector basis, and usually by a single government entity or individual companies. This fragmented approach has come up significantly short, lacking a broad, bird's eye view perspective. It often with a limited diversity of knowledge and viewpoints used to support the decision-making.

The concepts presented in this report emphasize the need for a unified, holistic system. The development of this system is crucial to achieving balanced and integrated management of resources under the rapidly developing capabilities in governments, industry, and finance enabled by big data and artificial intelligence. Progression from a linear to a circular economy is essential, as is ensuring a more transparent and equitable distribution of benefits from resources.

UNRMS is put forward as the "Swiss Army knife" to tackle sustainability and technology challenges. It will include high impact technologies to encourage efficient discovery and modelling of in-place resources and allowing higher precision during recovery and processing.

UNRMS will provide a voluntary global standard for integrated resource management, within the framework of public, public-private and civil society partnerships. It will be uniformly applicable to all resources. It is noted that countries have sovereignty over all the resources located on their territory; they have independent legislation as well as full rights to manage their resources. UNRMS will provide the principles of good governance to be applied voluntarily by stakeholders at various levels – national, regional or at a project level.

UNRMS will consider resources not as isolated or independent sectors, but as of the part of the whole resource-base of an area, country or region. While different resource sectors will have many aspects that may have to be considered independently. UNRMS will have an integrated view of all resources and will comprise:

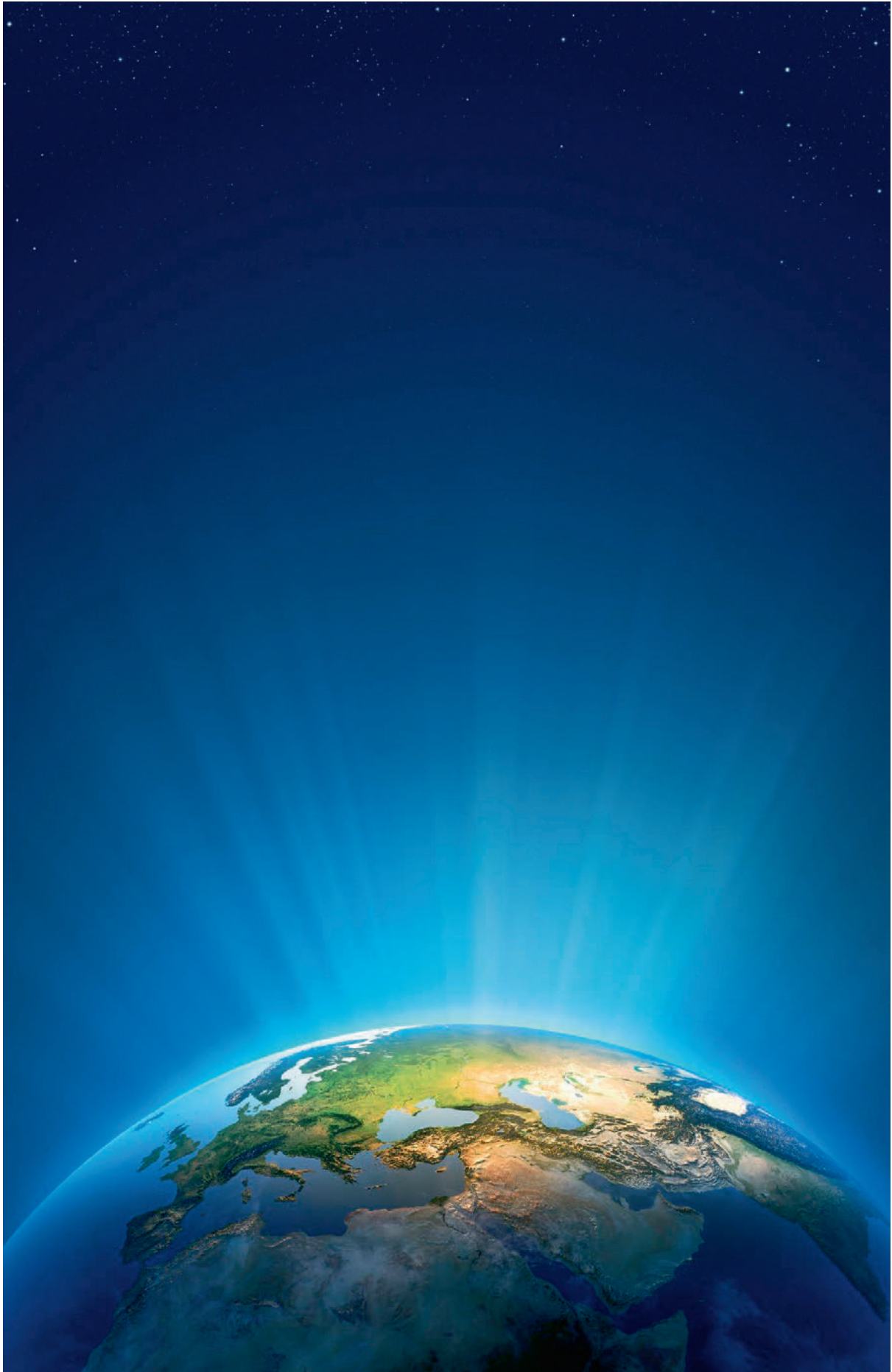
- Fundamental principles;
- Language – concepts and terminology;
- Structure and specifications – a framework to describe, classify, compare and show what is needed to progress projects;
- Data, analyses and standards – required by stakeholders to assess and compare options, make choices and monitor performance;
- Guidelines – how to reach decisions leading to the desired developments.

For sustainable resource management to be holistic, i.e., to be able to respond to the complexity of all resources, time and space scales, and life cycles, it should be principles-based. From the fundamental principles, specifications, or rules could be established at a lower level. Provisional fundamental principles introduced in this report are:

1. State rights and responsibilities in the management of resources;
2. Responsibility to the planet;
3. Integrated and indivisible management of resources;
4. Social contract on natural resources;
5. Service orientation;
6. Comprehensive resource recovery;
7. Circularity;
8. Health and safety;
9. Innovation;
10. Transparency;
11. Continuous strengthening of core competencies and capabilities.

Since UNRMS proposes a model for holistic, integrated and indivisible management of resources, appropriate human capabilities must be in place to drive it. These capabilities need a level of “T-shaped specialisation” that can see inter-connections, linkages and new patterns. Therefore, UNRMS will also focus on cross-cutting capabilities and communications that will contribute to developing a full social licence to operate.

With the availability and application of UNRMS, stakeholders will have the necessary toolkit to support sustainable resource management. A new holistic methodology for decision-making will now be possible aligning to the Sustainable Development Goals (SDGs), assuring the well-being of the people and the planet.



## 1. INTRODUCTION

The United Nations Resource Management System (UNRMS) will be a comprehensive, resource management system for sustainable development that is expected to be future-facing. It will support stakeholders in various goals, including aiding incorporation of circular economy wherever possible. The critical goal of UNRMS is to support the United Nations Decade of Action<sup>1</sup> (2020–2030) for accelerating sustainable solutions for resource management. UNRMS will be a voluntary global standard for integrated resource management, within the framework of public, public-private and civil society partnerships. UNRMS will consider various resources not as isolated or independent sectors, but as part of the whole resource base of an area, region or country. It will be uniformly applicable to all resources.

The transformative 2030 Agenda for Sustainable Development (2030 Agenda) has inaugurated a new era in global development. This era is marked by a new narrative expressed in business process language, of pursuing “economic, social and environmental” gains in equal measure, with a commitment to meeting the needs of two key beneficiaries “people” and “planet” through the common goal of sustainable “prosperity” for all. As a first transformative first step, the United Nations Framework Classification for Resources (UNFC) in its current form has incorporated guidelines for applying social and environmental considerations to resource classification and management<sup>2</sup>. These guidelines support the classification of resources in a manner that allows environmental, social and economic aspects. A second such step is proposed in this report, i.e., defining the core concepts, objectives and requirements of sustainable resource management to build UNRMS. The underlying principles and assumptions will be aligned to the SDGs.

### 1.1 TOWARDS BUILDING A UNIFIED RESOURCE MANAGEMENT SYSTEM

UNFC has been used since 1997 to classify and report mineral resources. Petroleum, nuclear fuel, renewable and anthropogenic resources were added, as well as the classification of injection projects for geological storage. Specifications (rules of application) for the use of UNFC for groundwater are under development. UNFC is also aligned with other international and national codes and systems. Thus, over the years, UNFC has developed into a unified system for the classification of a broad range of resources.

UNRMS builds on and is an extension of UNFC. The strength of UNFC fundamentally rests in its capability to parse information at a specific point in time according to: environmental-social-economic viability, technical feasibility and degree of confidence. It is aimed to steward a resource from discovery to final production and site restoration. UNRMS is entirely complementary to and a logical extension of UNFC, providing a toolkit for the systemic development of a project through time, whether comprising a single resource or combinations of different resources. It provides decision support for the user on what to do next.

This report is a compilation of the initial ideas presented in several previous Expert Group on Resource Management (EGRM) documents such as:

- 2018 - Transforming our world’s natural resources: A step change for the United Nations Framework Classification for Resources? (ECE/ENERGY/GE.3/2018/7)<sup>3</sup>

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<sup>1</sup> See Ten years to transform our world <https://www.un.org/sustainabledevelopment/decade-of-action/#:~:text=2020%20needs%20to%20usher%20in,and%20closing%20the%20finance%20gap>.

<sup>2</sup> See revised draft guidance for accommodating environmental and social considerations in the United Nations Framework Classification for Resources [https://www.unece.org/fileadmin/DAM/energy/se/pdfs/egrm/egrm11\\_apr2020/EGRM-11-2020-INF4\\_Env\\_SocialGuidance\\_UNFC\\_Draft\\_6c.pdf](https://www.unece.org/fileadmin/DAM/energy/se/pdfs/egrm/egrm11_apr2020/EGRM-11-2020-INF4_Env_SocialGuidance_UNFC_Draft_6c.pdf)

<sup>3</sup> See [https://www.unece.org/fileadmin/DAM/energy/se/pp/unfc\\_egrm/egrc9\\_apr2018/ece.energy.ge.3.2018.7\\_e.pdf](https://www.unece.org/fileadmin/DAM/energy/se/pp/unfc_egrm/egrc9_apr2018/ece.energy.ge.3.2018.7_e.pdf)

- 2019 - United Nations Resource Management System: Concept and design (ECE/ENERGY/GE.3/2019/10)<sup>4</sup>
- 2020 - UNRMS Concept note: Objectives, requirements, outline and way forward (ECE/ENERGY/GE.3/2020/4)<sup>5</sup>
- 2020 - Use of UNFC and UNRMS for sustainable development: Global values, regional circumstances, priorities and needs for resource management in age of big data and artificial intelligence (ECE/ENERGY/GE.3/2020/7).<sup>6</sup>

## 1.2 INTEGRATED AND INDIVISIBLE MANAGEMENT OF NATURAL RESOURCES

With the adoption of the 2030 Agenda, which enumerates the 17 SDGs, a new direction has been provided for the management of all activities in the social and economic space. The SDGs call for the “integrated and indivisible” management and development of resources for the benefit of the present, without compromising the ability of future generations to meet their own needs.

Societal development needs are primarily satisfied by the production and use of primary and anthropogenic resources, which also constitutes the core of the natural capital of the planet. Essential ecosystem services to the society comprise, for example, access to food, raw materials, energy, mobility, clothing, dwelling, art, carbon sequestration, purification of water and air, nutrient recycling and soil formation. The dependency of natural resources on development places the Expert Group on Resource Management of the United Nations Economic Commission for Europe (UNECE) in a unique position to provide a unified and holistic framework for assuring that resources are produced and used in a manner that is consistent with the SDGs. The Expert Group recognized this strength during the discussions that started in 2012 on formulating social and environmental guidelines for UNFC application as previously mentioned.

However, it was soon recognized that UNFC, being a project-based classification and reporting standard of product quantities may easily be extended to other information carried by projects. This will be necessary but not sufficient for the holistic management of resources for the attainment of the SDGs. In 2017, a decision was taken by UNECE member States to develop UNRMS. This will extend UNFC to facilitate integrated and holistic decision support for the management and development of resources.

The resource management system needs to be designed with the SDGs as the fundamental elements. The concepts presented in this publication are crucial for balanced and integrated management of resources under the rapidly developing capabilities in governments, industry, and finance enabled by big data and artificial intelligence. These include the movement from a linear to a circular economy, as well as ensuring a more transparent and equitable distribution of benefits from resources.

The challenges today seem global and unmanageable. Climate change, pandemics, forest fires, droughts and floods etc. are well beyond the scope of individuals, single companies or even individual countries. Whilst the solutions must be global, the beneficiaries need to include public, public-private and civil society partnerships.

## 1.3 SUSTAINABLE DEVELOPMENT GOALS AND RESOURCE MANAGEMENT

The SDGs, approved by 193 Heads of State in September 2015, “is a plan of action for people, planet and prosperity” whose stated objective is “Transforming Our World”<sup>7</sup>. This is unapologetically transformative

<sup>4</sup> See [https://www.unece.org/fileadmin/DAM/energy/se/pdfs/egrm/egrm10\\_apr2019/ECE\\_ENERGY\\_GE.3\\_2019\\_10.pdf](https://www.unece.org/fileadmin/DAM/energy/se/pdfs/egrm/egrm10_apr2019/ECE_ENERGY_GE.3_2019_10.pdf)

<sup>5</sup> See [https://www.unece.org/fileadmin/DAM/energy/se/pdfs/egrm/egrm11\\_apr2020/ECE\\_ENERGY\\_GE.3\\_2020\\_4.pdf](https://www.unece.org/fileadmin/DAM/energy/se/pdfs/egrm/egrm11_apr2020/ECE_ENERGY_GE.3_2020_4.pdf)

<sup>6</sup> See [https://www.unece.org/fileadmin/DAM/energy/se/pdfs/egrm/egrm11\\_apr2020/ECE\\_ENERGY\\_GE.3\\_2020\\_7.pdf](https://www.unece.org/fileadmin/DAM/energy/se/pdfs/egrm/egrm11_apr2020/ECE_ENERGY_GE.3_2020_7.pdf)

<sup>7</sup> See <https://sustainabledevelopment.un.org/post2015/transformingourworld>



phrasing, whereby the adjectival “Triple Bottom Line” (TBL)<sup>8, 9</sup> “win/win” triad of “economic, social, and environmental” returns is used. The usage of TBL was coined by Elkington in 1994 as a way of describing the potentially profitable relationship between corporate business and sustainable development goals as set out in the 1987 Brundtland Report.<sup>10</sup> TBL concept has dominated both the United Nations (UN) thinking and its related administrative behaviour since the mid-1990s, and is taken up into a new UN triad of substantives, “people, planet and prosperity”.

This new triad is all the more transformative in that it rearranges the sequence in which the TBL returns are to be measured, placing people (“social”) first, planet (“environmental”) second and “prosperity” (“economic”) third and in such way that is deliberately syllogistic in nature. If people – the planet’s human resources - are more justly treated (SDG 16), better educated (SDG 4) and possessed of more outstanding capabilities (SDGs 9 and 11), and if the planet’s other – non-human - natural resources are managed in a more sustainable manner (SDG 12), i.e., as a “non-zero-sum” game, greater prosperity and resilience will be the outcome. Or, simplified, if the tangible resources of people and planet enhance their capacities to meet each other’s needs, short- and longer-term, the intangible benefit of increased and sustained prosperity across generations to come will follow. This approach puts a double emphasis on “prosperity”, both economic and ethical. As suggested by its etymology – “doing well”<sup>11</sup> in our own generation obliges us likewise “do well” by generations to come by passing through to them the capacity to live as well as or better than use; or, as they might express it in retrospect, “our forebears have enabled us to prosper<sup>12</sup> as we might have hoped they would”.

However, the people-planet-prosperity triad is construed, undoubtedly, a critical dependency, and perhaps *the* critical dependency for sustained prosperity will be to reappraise the way, and purposes for which, we find, recover, supply, use and reuse our natural resources, both primary and secondary. Claude Levi-Strauss observed that cultures are never more vulnerable than when they lose the ability to challenge their base assumptions<sup>13 14</sup>. The SDGs challenge to resource management is to conduct such a review of itself.

#### 1.4 CHALLENGES TO SUSTAINABLE RESOURCE MANAGEMENT

Sustainable resource management is defined as the total of policies, strategies, regulations investments, operations and capabilities within the framework of public, public-private and civil society partnerships, and based on environmental-socio-economic viability and technical feasibility, which determine what, when and how resources are developed, produced, consumed, reused and recycled by the society.

However, sustainable resource management faces a myriad of challenges today including economic aspects such as market volatilities, long-term decline in productivity<sup>15</sup> and fluctuation of commodity prices, persistent

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<sup>8</sup> Elkington, J. (1994). Towards the sustainable corporation: Win-win business strategies for sustainable development. California Management Review 36, no. 2: 90-100.

<sup>9</sup> Elkington, J. (1997). Cannibals with Forks: The Triple Bottom Line of 21st Century Business. USA: New Society Publishers.

<sup>10</sup> Brundtland G. (ed) (1987) Our Common Future. The World Commission on Environment and Development, Oxford University Press, Oxford.

<sup>11</sup> For the etymology of “prosperity” see <https://en.oxforddictionaries.com/definition/prosperity>

<sup>12</sup> For the etymology of “prosper” and its derivation from Latin “pro sperere” meaning “hope” See <https://www.etymonline.com/word/prosper>

<sup>13</sup> Levi-Strauss, C., (1955), Tristes Tropiques, Paris, Librairie Plon.

<sup>14</sup> Levi-Strauss, C., (1958), Anthropologie structural Paris, Librairie Plon.

<sup>15</sup> UNCTAD (2017) Commodities and Development Report 2017 - Commodity Markets, Economic Growth and Development (UNCTAD/SUC/2017/01) [https://unctad.org/en/PublicationsLibrary/suc2017d1\\_en.pdf](https://unctad.org/en/PublicationsLibrary/suc2017d1_en.pdf)

issues in maintaining demand and supply balance, eroding investor confidence, failure to address social and environmental impacts, geo-political issues and conflicts.

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#### A. ASYNCHRONOUS AND INCONSISTENT AVAILABILITY OF DATA

Sustainable resource development is rarely a one-person operation or one particular sector of the economy. It usually requires complex interactions with diverse sectors, and often large multidisciplinary teams will have to work together. Adherence to the 2030 Agenda and the national or regional sustainable development programme will require compliance with the full gamut of relevant regulations, full integration into a company's business model and a rich understanding of the intricacies of actual project implementation.

Such an intricate web of activities requires ongoing and real-time access to consistent and accurate data, with an understanding of how to cope with its inherent uncertainty. When a web of actions expanding from a traditional "profit only" motive to a process that targets good social and environmental outcomes, complexity naturally increases. With this increasing complexity, there is always a danger in asynchronous availability of data between different players in the game. Often the policymakers, decision-makers and the project personnel are not on the same page because not all are equally possessed of the same information.

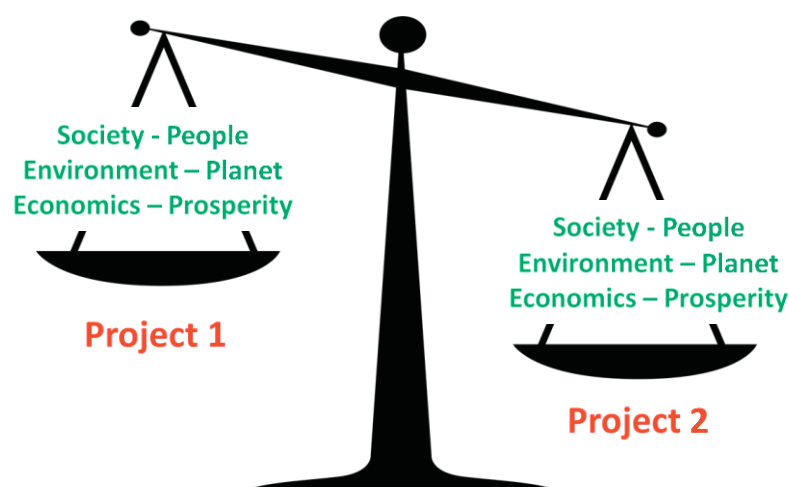
The players at all levels have a need to identify the options available, along with their maturity, opportunities and barriers to development. All options come with upsides and negatives, risks and challenges. At various times during the project life cycle, reasoned choices balancing the social, environmental and economic aspects of any development need to be made.

Progress is not a time-stamped set of activities. Performance improvements should happen all the time. For this, it is essential to analyse the outcome of a project to better guide decisions in the future. The initiation of a project today and its governance on an ongoing basis are both important.

For a resource development project, all these are not just good project management practices, but decision and actions that are coupled to resource quantities that could be available for production. Whether they are non-renewable raw materials or renewable energy, a set of criteria and filters will have to be applied and the outcomes forecasted in a system-wide manner.

Good decision-making depends on data, information and knowledge of the outputs, outcomes and impacts of a project. With reverse tracing (or reverse engineering) from the desired end-point of People-Planet-Prosperity back to project selection and design, projects may have to be weighted on their forecasted outcomes (Figure 1), while progress will be measured in terms of actual achievements. While the project that carries the maximum benefits requires the focused attention today, a project on the other side of the scale will also require attention to make it more substantial on the benefit side, so ensuring equilibrium of benefit during delivery.

Figure 1.  
Weighing of projects based on social, environmental, and economic returns



The assessment of the possible outcomes is made extremely difficult not only by the “unknowns”, such as market volatilities, political instabilities or natural hazards but also the “unknown unknowns” about which we are unable to even speculate. The future is not predetermined but shaped by the many decisions and actions taken (good and bad) going forward. A good decision maker’s or project implementor’s approach to the extreme uncertainties of the future should be to avoid the “unknowns” when such activities have value or manage them through investments in flexibility to minimise the negative impacts and increase the exposure to the upsides of the plausible “unknown unknowns”.

Financing a resource-development project requires an assessment of its investment readiness. This is also hinged to the clarity of information available. Scientific rigour is not only demanded to understand the return on investments. A growing tribe of investors today are also particularly curious about the social and environmental returns as well. Smart and flexible financing in the future will put more stringent requirements on data and decision support in the form of structured information. As an example, the Financial Stability Board began in 2020 to ask whether it would be possible to assess the temperature rise that the projects they finance through their portfolios will cause<sup>16</sup>. Their members had then over 100 trillion USD under management.

Consistent data, information and knowledge, are crucial for the progress of a project. However, for many resource projects, these are only partially available. A toolkit for the integrated and sustainable management of resources that utilizes UNFC based data and information for decision-making support is sorely lacking.

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## B. GOING BEYOND THE “COMMODITY” MINDSET

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

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<sup>16</sup> See Task Force on Climate-related Financial Disclosures: Status Report <https://www.fsb.org/2018/09/task-force-on-climate-related-financial-disclosures-status-report/>

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.

UNFC was significantly updated in 2009. Rapid progress was made to cover an ever-wider set of resource categories including nuclear energy, renewable energy and injection projects. Then a second significant step-change came with the adoption of anthropogenic resources opening it up for application to circular economies. More recently, groundwater resources are an area of focus. These developments led to an adjustment and update of UNFC terminology in 2019. The update has facilitated the seamless and consistent use of UNFC across resource sectors. Social and environmental guidelines were incorporated into the progressively revised framework. The progress has led to significant growth in attendance at the annual meetings of the Expert Group on Resource Management and a noticeable upturn in the use of UNFC by government entities around the world. Currently, a review of commercial applications of the UNFC is underway, identifying a requirement to include management information carried by projects beyond product quantities. This includes information on assets, i.e. the legal rights to participate in projects, costs, revenues, values, labour, emissions etc.

Currently, the application of UNFC remains somewhat siloed. Each different resource sector works currently under separate specifications. However, as the UNFC is adopted, it standardizes the language and interpretations in a fashion that are comparable across those silos. 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 toolkit for integrated resource management.

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 the OR”,<sup>17</sup> or the tendency disregard alternate solutions, 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.

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 has given way today to the 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.

Meanwhile, alternative approaches 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

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<sup>17</sup> See Collins, Jim (2004) *Built to Last: Successful Habits of Visionary Companies*, Harper Business. Instead of being oppressed by the “tyranny of the OR,” highly visionary companies liberate themselves with the “genius of the AND”—the ability to embrace both extremes of a number of dimensions at the same time. Instead of choosing between A OR B, they figure out a way to have both A AND B. See Chapter 3 for further discussions on the matter.

practice. For this reason, the circularity “gap” remains high.<sup>18</sup> Climate change, though, is recognized as a grave threat and decarbonization as a primary objective.

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### C. UNDERSTANDING THE NEW SDG-DRIVEN SYSTEM BOUNDARIES

What techniques can be developed to map the boundaries of the new SDG-driven natural resource management system? In seeking to map the system boundaries, some of the high-level approaches will have to address several issues, as shown in Table 1.

**Table 1.**  
**Mapping SDG-driven system boundaries**

"Vertical" issues	Production
	Residues/ legacy co-products
	Conflicted land uses
	Water resources
	Energy resources etc.
"Horizontal" issues	Competences, expertise and experience
	Policies, with the intention to enhance governance, transparency, treaty or SDG compliance
Possible "eco-system"-wide solutions /zero waste convergences	By integrated, sequential resource management (the "whole basin comprehensive resource recovery" approach)
	By targeted co-locations and combinations

Consistent with re-centring on secondary sources, the conventional model of “greenfield” projects preceding “brownfield” will be reversed for:

- Brownfield, unlocking value and resource release from a highly costly, possibly abandoned legacy site; and
- Greenfield, an innovative way to design and execute a new project that avoids the pitfalls and traps of the brownfield models.

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### D. SOCIAL AND ENVIRONMENTAL IMPLICATIONS

The process of sustainable resource management starts from an understanding of the world’s natural capital and natural resources, including the efforts required to refine and use them, and how this relates to societal needs. Natural capital is the world’s stocks of natural assets. It is a concept for a plurality of connected, heterogeneous stocks that perform various functions and services for human society. Natural capital includes a variety of components such as water, geology, biodiversity, soil, ozone layer and properties like ecological resilience, ecosystem health and integrity.

Natural resources are parts of the natural capital that can be used in economic activities to produce goods and services. Material resources such as minerals, petroleum, nuclear fuels, injection projects<sup>19</sup>, anthropogenic

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<sup>18</sup> 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](https://assets.website-files.com/5e185aa4d27bcf348400ed82/5e26ead616b6d1d157ff4293_20200120%20-%20CGR%20Global%20-%20Report%20web%20single%20page%20-%20210x297mm%20-%20compressed.pdf)

<sup>19</sup> For Injection Projects for the purpose of Geological Storage, the resource is the reservoir available for geological storage.

resources<sup>20</sup>, renewable energy resources such as geothermal, solar, wind, biofuels and water resources could be considered as natural resources. However, the natural resource base extends beyond what is referred to here. It could include elements such as land, soil, crops, forests and timber.

It is also recognized that material resource consumption is increasing at a steady rate of 2.5 to 3 per cent per annum. Current global use of material resources (biomass, metals, fossil fuels and non-metallic minerals) is about 90 billion tonnes per annum.<sup>21</sup> At the rate of growth previously mentioned, production and use of resources will likely breach the carrying capacity of the planet very soon. Therefore, there is an urgent need to decouple economic growth, resource use and environmental impacts, recognizing the needs of a large and growing population coming out of poverty so that human well-being improves while environmental impacts remain manageable.

The social and environmental issues associated with resource projects include the impacts of climate change, water stress, desertification and biodiversity loss. About 50 per cent of carbon emissions and 90 per cent of biodiversity loss are caused by production and use of resources<sup>22</sup>. Population growth and accelerated rates of urbanization further exacerbate these impacts. Because of all these impacts, the resource industry faces a need for reform. The associated uncertainties are huge, which is reflected in investor and social dissatisfaction.

While recognizing that some of the challenges mentioned above are widespread in the general economy and industrial sectors, the resource management undertaken by governments, combined with the efforts of the industry as financed by the capital market is what can change the situation.

Addressing some of the challenges mentioned above will require a new toolkit for sustainable resource management. UNRMS is being designed as such a toolkit. It will be a comprehensive system for accounting and decision support that is expected to be future-facing and assist stakeholders in attaining various goals, including progress towards a circular economy.

## 1.5 UNRMS AND THE INTEGRATED MANAGEMENT OF RESOURCES

There needs to be a fundamental change in how resources are managed. The transformation should embrace the essential need to improve resource efficiency and reduce the impact on the environment, climate change and biodiversity.

Resource management decisions have historically been made on a project-by-project or sector-by-sector basis, and usually by a single government entity and companies involved in the respective sectors. This fragmented approach has come up significantly short, lacking a broad, “bird’s-eye” perspective and often with a limited diversity of knowledge and viewpoints used to support informed decision-making<sup>23</sup>.

The limitations of ever-present siloed management practices are becoming more evident, leading to conflict, delays and severe losses to natural capital. The world needs to improve the way it plans and manages resources to less siloed processes and more integrated approaches.

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<sup>20</sup> Anthropogenic resources are natural resources that are modified by humans. As with many resources that are modified by the biological systems, anthropogenic resources too are intimate part of the natural resource base.

<sup>21</sup> International Resource Panel (2019) Global Resources Outlook 2019 <https://www.resourcepanel.org/reports/global-resources-outlook>

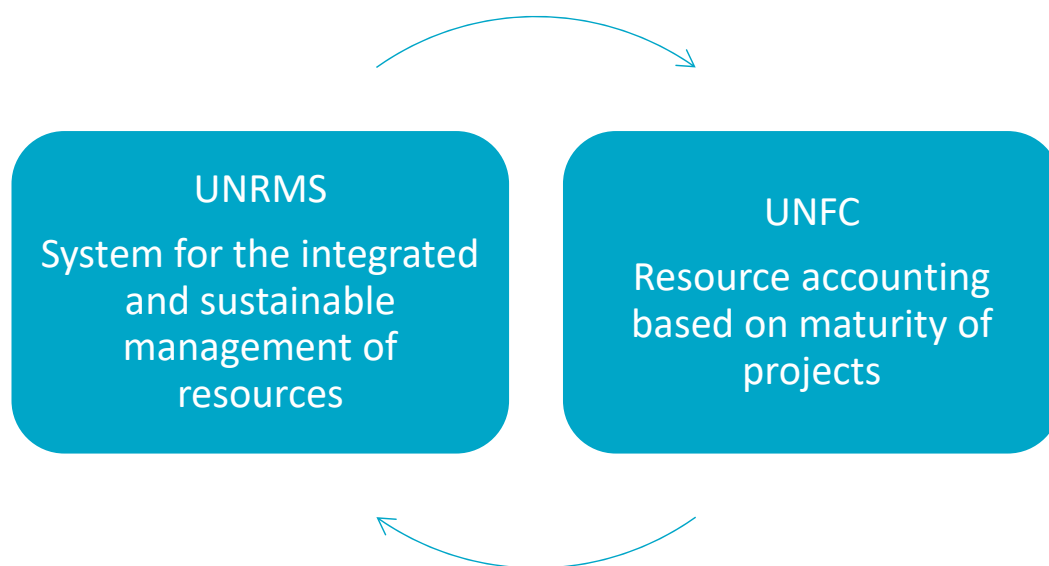
<sup>22</sup> International Resource Panel (2019) Global Resources Outlook 2019 <https://www.resourcepanel.org/reports/global-resources-outlook>

<sup>23</sup> Council of Canadian Academies (CCA) Greater Than the Sum of Its Parts: Toward Integrated Natural Resource Management in Canada <https://cca-reports.ca/reports/the-state-of-knowledge-and-practice-of-integrated-approaches-to-natural-resource-management-in-canada/>

Integrated management of resources is the key to overcoming the challenges faced by the world. UNRMS will, therefore, embrace the critical concept of integrated resource management that considers complexity, multiple scales, and competing interests, and brings these together to make informed decisions.

One of the benefits of UNRMS will be to support higher-order decision-making that encompasses land use planning and strategic assessment of resources at national or regional scales hence enabling better and more efficient decision-making at the project-specific level. In this manner, UNRMS will bring a holistic, programmatic, systems and life cycle view of resource management that will plug into the resource-specific and project-based classification of UNFC and implementation of the projects (Figure 2). UNFC enables resource accounting based on decisions taken, whereas UNRMS will provide support for future decisions.

**Figure 2.**  
**Schematic connection of UNRMS to UNFC and project-level implementation**



## 1.6 UNFC AND UNRMS: A MARRIAGE FIT FOR SUSTAINABLE DEVELOPMENT

UNRMS proposes to be the Swiss Army knife to tackle the sustainability and technology challenges especially high impact technologies (mostly digital in one form or another) which allow better exploration and modelling of in-place resources and higher precision during recovery and processing that also indicates the potential for a major change in the underlying economics. In this aspiration, UNRMS will build on the strengths of UNFC, which fundamentally rests in its capability to analyze forward-looking information on social-economic viability; project feasibility and level of knowledge to steward an asset from its discovery to final production (Table 2).

UNFC is a tool for assessment of the volumes/quantities in a resource-base and assigning it a class that indicates its distance or closeness to the production gateway. UNFC-based data and information represent a snapshot in time (synchronic time), and which is defined under the commercial conditions and associated opportunities and constraints.

UNRMS, on the other hand, will be the toolkit for the development of a project, an essential element is the sustainable development pathway through time (diachronic time) (see Table 2 for a comparison). How a project, however small or big, performs adds to how sustainably resources are ultimately managed. UNRMS allows stripping down the project into its fundamental issues and creating new knowledge-based solutions.

Though an essentially reductionist approach, the UNRMS principles and rules will ensure a stable anchoring of the project to the required endpoints of good social and environmental outcomes. While UNFC aids in labelling resource classes, UNRMS will advance it to higher classes.

**Table 2.**  
**The UNFC and UNRMS convergence**

<i>UNFC</i>	<i>UNRMS</i>
<p>Stewardship of an asset</p> <p>A tool for quantifying the volumes produced, recoverable and unrecoverable from all possible projects in a source (note that in application to renewable energy UNFC quantifies the volumes associated with a single project)</p> <p>A point in time view under defined commercial conditions, opportunities and constraints</p>	<p>Development of a project, which is an integral piece in the sustainable development programme</p> <p>An aid to decision-makers measuring the actual progress of a project through the development stages and programme managers on how it contributes to sustainable development</p> <p>Project management considering all metrics to the decision-makers including volume/quantities from UNFC, rate profile, economic indicators, environmental performance, social outcomes</p> <p>The toolkit for implementation, analysis and governance at the project level</p>









## 2. UNITED NATIONS RESOURCE MANAGEMENT SYSTEM: OBJECTIVES AND REQUIREMENTS

The critical role of efficient management of natural resources in achieving almost all of the SDGs is clearly recognized in the 2030 Agenda. In this context, efficient management means a process which is both “integrated and indivisible and balance[s] the three dimensions of sustainable development: the economic, social and environmental”. This observation moves the economics of resource management firmly into the domain defined by John Nash in his papers on equilibrium theory as those transaction types where parties either both win or both lose<sup>24</sup>. What has characterized the past century of resource management is the successive boom and bust cycles, with negative externalities such as pollution and discarded wastes imposed by one generation on the next, typically at a very high cost.

Such a systemic approach is a primary conclusion of the International Resource Panel (IRP) Report, *Assessing Global Resource Use: A systems approach to resource efficiency and pollution reduction*. The above report indicates that about 90 billion tonnes of resources such as biomass, fossil fuels and non-metallic minerals were used in 2017. This is three times the quantity used in 1970, and by 2050<sup>25</sup> the resource demand is likely to double to approximately 180 billion tonnes/year. “Focusing on single resources, single economic sectors, or single environmental and health impacts will not achieve the collective visions of the Sustainable Development Goals,” the report says. What is needed is a “systems approach which connects the flow of resources – from extraction through to final waste disposal – with their use and impact on the environment, economies and societies at each stage of the life-cycle”.

While SDG 12 on sustainable production and consumption is at the core of this approach, a systems approach requires that it links directly or indirectly to all the other goals, notably SDG 7 on affordable and clean energy; SDG 9 on the industry, innovation and infrastructure; SDG 11 to make cities and human settlements inclusive, safe, resilient and sustainable; and SDG 13 to take urgent action to combat climate change and its impacts.

### 2.1 UNRMS REQUIREMENTS

UNRMS will be a voluntary global standard for integrated resource management, within the framework of public, public-private and civil society partnerships, and will be uniformly applicable to all resources. States have sovereignty over their resources located on their territory, have independent legislation and full rights to manage their resources. UNRMS will provide only the principles of good governance, which can be applied by States on the principle of voluntariness. UNRMS will consider various resources not as isolated or independent sectors, but as of the part of the whole resource base of an area, region or country. However, various resource sectors will have many aspects that may have to be considered independently. A discussion will be required on what is the appropriate universal model, but one perspective is:

1. Governments set framework conditions allowing;
2. Resource industry to deploy their best capabilities in ways that;
3. The capital market can finance.

Primary users of UNRMS will be:

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<sup>24</sup> Osborne, M. J. and Rubinstein, A. (1994). *A Course in Game Theory*. Cambridge, MA: MIT.

<sup>25</sup> With resource use expected to double by 2050, better natural resource use essential for a pollution-free planet, UN Environment 2017, <https://www.unenvironment.org/news-and-stories/press-release/resource-use-expected-double-2050-better-natural-resource-use>



1. Governments/regional bodies;
2. Resource industry;
3. Capital investment entities including stock exchanges and banking sectors;
4. Academia, non-profit organizations, communities including indigenous communities and the public.

A detailed provisional view on the needs of these different stakeholders is given in Table 3.

**Table 3.**

**Primary users of UNRMS and requirements – A provisional view**

<b>A. Governments/Regional bodies</b>
<b>Achieving the SDGs, including climate objectives</b>
<b>Formulation of regional and national policies on energy and raw materials for sustainable development</b>
<b>Assuring the security of supply and fulfilling demand, including assessment of the global stocks and flows and ensuring access to resources</b>
<b>Planning, including the formulation of fiscal policies</b>
<b>Framing the necessary laws and regulations</b>
<b>Assessments of national risks and opportunities</b>
<b>Maintain national data inventories</b>
<b>Revenue management</b>
<b>Developing international standards beyond the existing ones necessary for elevated challenges of the future</b>
<b>Supporting global market development</b>
<b>Increasing resource management efficiency and capturing the value of resources at the source of production</b>
<b>Developing hard and soft infrastructures</b>
<b>Managing social issues</b>
<b>Managing land use</b>
<b>Managing employment issues</b>
<b>Managing nature protection issues</b>
<b>Implementing health, safety and environmental protection measures</b>
<b>Aiding partnership and conflict resolution</b>
<b>Improving education and research</b>
<b>Mitigating and managing impact of climate change</b>
<b>Managing the impact of natural disasters</b>
<b>Developing disclosure requirements</b>
<b>B. Industry</b>
<b>Strategic planning, including managing resource portfolio, supply and product chains under valid business models.</b>
<b>Ensuring alignment of stakeholder interests</b>
<b>Supporting capital investment decision-making</b>
<b>Strengthening social and environmental controls</b>

<b>Building resilience</b>
<b>Stress testing</b>
<b>Operations management</b>
<b>Serving financial obligations</b>
<b>Developing and deploying capabilities</b>
<b>Building partnerships</b>
<b>Supporting research and development</b>
<b>Assisting mergers and acquisitions</b>
<b>Assessing business proposals including risks and opportunities</b>
<b>Securing returns on investments</b>
<b>Managing opportunities and risks at the portfolio level</b>
<b>Managing projects and corporate risks and opportunities</b>
<b>Managing disclosure requirements</b>
<b>C. Capital investment entities including stock exchanges and banking sectors</b>
<b>Supporting investment analysis and decision-making</b>
<b>Developing capital ownership policies and practices</b>
<b>Developing disclosure requirements from invested entities</b>
<b>Developing self-reporting requirements</b>
<b>D. Academia, Non-profits, Indigenous Communities and the Public</b>
<b>Resource flow modelling at various space and time-scales</b>
<b>Understanding the complexities of integrated resource management</b>
<b>Assisting technology development with a systems perspective</b>
<b>Cross-disciplinary capacity building</b>
<b>Sustainable development support</b>
<b>Education and training</b>
<b>Ensuring gender equality and diversity</b>
<b>Managing the traditional rights of the indigenous people</b>
<b>Aiding futuristic studies</b>
<b>Enhancing stakeholder communications</b>
<b>Building International Centres of Excellence on Sustainable Resource Management (ICE-SRM)</b>

As a toolkit to support the implementation of the objectives of the 2030 Agenda, the immediate beneficiaries of UNRMS are as set out in Table 3x. Still, society as a whole will have an advantage in having an UN-approved Resource Management System as the toolkit for sustainable resource development decision support. In general, UNRMS will provide different stakeholders with:

1. Information and relationships for integrated resource management for realization of the 2030 Agenda;
2. Standards and conditions for shaping dynamic and integrative public, public-private and civil society partnerships pointing to:

- a. Appropriate international conventions, national laws and regulations;
- b. Standards and requirements for capital investment;
- c. Standards and conditions for the industry to operate;
- d. (Gaps and needs for further regulation and standards.

Sustainable resource management using UNRMS will have to optimize sustainable benefits to all stakeholders within the people-planet-prosperity triad and with cross-sectoral nexus linkages and minimize all potential adverse impacts. Sustainable resource management by governments and across governments thus needs to operate with long-term objectives.

## 2.2 THE OUTLINE OF UNRMS AND WAY FORWARD

UNRMS will have an integrated view of all resources and will comprise:

1. Fundamental principles;
2. Language – concepts and terminology;
3. Structure and specifications – a framework to describe, classify, compare and show what is needed to progress projects;
4. Data, analyses and standards – required by stakeholders to assess and compare options, make choices and monitor performance;
5. Guidelines – how to reach decisions leading to the desired developments.

The Expert Group on Resource Management intends to develop a system for resource management, which is useful for and applicable by all stakeholders. For this to be successful, a top-down developmental model would be premature and could be self-defeating. The system should be developed, to the extent possible, addressing the challenges and requirements of resource management at a user and project level. For this reason, UNRMS development should be ideally done with substantial stakeholder consultations, including pilot studies at regional or national levels. The system needs to grow organically with a build-measure-learn model of iterative development.

The components of UNRMS and proposed activities needed to develop the system are shown in Figure 3. As far as practical, UNRMS will be built on UNFC, but extensions and additional tools and guidelines will be required.

It is expected that UNRMS will be widely used by resource management stakeholders across sectors and jurisdictions. It will serve as a voluntary global standard recognized by relevant stakeholders for transparent, consistent, and complete management of resources within the framework of public, public-private and civil society partnerships. It is most relevant to governments, regulators, investors and industries for integrated management of resources. The expected and actual performance of a wide variety of projects, as well as their interactions, is reported and compared in terms of their environmental, social and economic impacts (triple bottom line reporting), thereby informing decision-makers, and those impacted by resource projects, how these contribute to the SDGs and their situations.

The initial aims of UNRMS development are expected to be:

1. Develop a facility for linking management of all resources drawing, among other things on the UN System of National Accounts (SNA) and its System of Environmental-Economic Accounting (SEEA). This would provide data both to enable planning national energy provision and assessing the SDG impacts of existing and planned projects (or groups of projects);

2. Strengthening analyses of the effects of policy and public framework reforms on industrial and market developments. This analysis would then provide the basis for guidance on national policy and public frameworks to achieve the desired outcomes;
3. Develop standard processes and tools that facilitate resource management processes among member states and in public-private partnerships within member states. These standards and tools would secure development efficiency and support the development of national inventories and enable them to be combined to give a holistic view.

**Figure 3.**  
Provisional outline of UNRMS and initial activities

Elements of UNRMS		Initial activities to Develop UNRMS				
<b>Principles</b>	Fundamental principles for sustainable resource management  A draft set of principles has been proposed	Questionnaire to understand stakeholder needs and priorities, and to gather ideas for solutions	Follow-up discussions with stakeholders	Pilot studies to develop requirements and test solutions, in cooperation with interested stakeholders	Design preliminary solutions, building on existing principles, methods and tools where appropriate	Run early adoption cases to demonstrate value and identify shortcomings
<b>Language</b>	Concepts and terminology  Some concepts and common terminology already developed for UNFC, but additions will be required for UNRMS					
<b>Structure and Specifications</b>	Framework and specifications to describe, classify, compare and progress projects  Is the UNFC structure sufficient? If not then either modify it or develop a separate structure into which UNFC categories can be mapped					
<b>Data</b>	Data, standards and guidelines for analysis  Required by stakeholders to assess and compare options, make choices and monitor performance. Different stakeholders will require different data e.g. government policy makers, investors, operators, communities					
<b>Guidance</b>	Guidance on how to influence and select outcomes to meet stakeholder needs and SDGs					

The need for integrated and dynamic resource management, as called for by various international initiatives, including the 2030 Agenda, is briefly explained here.

The following initial development activities have been identified:

- Questionnaire to understand stakeholder needs and priorities, and to gather ideas for solutions;
- Follow-up discussions with stakeholders;

- Pilot studies to develop requirements and test solutions, in cooperation with interested stakeholders;
- Design preliminary solutions, building on existing principles, methods and tools where appropriate;
- Run early adoption cases to demonstrate value and identify shortcomings.

A set of aims for initial work is suggested to provide:

- Data standards for planning national energy and raw material provision and assessing the SDG impacts of existing and planned projects (or groups of projects), based on UNFC, UN SNA and SEEA systems;
- The basis for guidance on national policy and public frameworks;
- Efficient standards and tools to support the development of national inventories and enable them to be combined to give a holistic view.

UNRMS, in essence, has to provide a “global workspace<sup>26</sup>”, which will aid the analysis and understanding of both the linear and non-linear impacts of several factors, clustered along the socio-economic and environmental, project feasibility and level of knowledge aspects. The system should aid the use of the knowledge so gleaned for effective decision-making, including channelling of investments and capital allocations.

UNRMS should not only be designed to address the present challenges to resource management, i.e., supporting sustainable production and consumption, but it should also be future smart. Some of the attended uncertainties of the future has been pointed out in earlier sections, but those raising from enormous volumes of resources required in the future, its footprint and needs, to operate in a carbon-constrained world merits the most attention.

Following the practices established by UNFC, the system will be multi-tiered with principles, specifications (rules) and guidelines (non-mandatory guidelines). But unlike a resource classification system, where rigidity is a virtue, resource management will allow for flexibility and adaptability through time as needs and priorities evolve. The flexibility of the system attains more meaning when viewed through the requirements of future-proofing. An adaptive (eventually Artificial Intelligence) environment where ideas can collide and be developed and applied is essential. Hence, some protocols, best practices and case studies are also needed.

### 2.3 A SYSTEMS APPROACH TO RESOURCE MANAGEMENT

A systems approach<sup>27</sup> to sustainable resource management could enable tighter integration of the policies, especially the sustainable development programme of a country or a company through to project-level implementation. Such an integration, if realized, will bring out an essential transformation in the resource management landscape, with emergent patterns, such as:

- **Resource centering**, the life-cycle management of resources
- **Value centering**, the discovery of economic resources and targeting social and environmental returns
- **Service or customer centering**, breaking away from the commodity paradigm

<sup>26</sup> The term "global workspace" comes from Artificial Intelligence, where it refers to a memory domain that allows for cooperative problem-solving by large collections of specialized programmes.

<sup>27</sup> A system is a set of things working together as parts of a mechanism or an interconnecting network; a complex whole. A system is more than the sum of its parts. It may exhibit adaptive, dynamic, goal-seeking, self-preserving, and sometimes evolutionary behaviour. Many of the interconnections in systems operate through the flow of information. Information holds systems together and plays a great role in determining how they operate. Systems approach is derived from systems thinking, which is used to identify and understand systems, as well as predicting their behaviours and devising modifications to produce desired effects. See Meadows, D. H. (2008). *Thinking in systems: A primer*. Chelsea Green Publishing.



- **Security of supply and criticality**, examining the strategic needs.

Each of the above is contributory to a transition in resource management from a linear to a circular economy, where all resources whether primary or secondary are retained to the fullest extent possible within the system boundaries resulting in a waste reduction to the point of eventual “zero waste”.

While economic gains and operating profits matter, these need not be the prime drivers of a new resource management model. Profits should follow good social and environmental outcomes. This is not a radical view; many businesses have been built on similar foundations for a century or more<sup>28</sup>.

Based on the first principles thinking of identification of current assumptions, collapsing the problem into its fundamental principles and creating new knowledge-based solutions, some of the core approaches in resource management can be easily identified. As mentioned in Chapter 2, this approach, which will have to be implemented at a project level, includes, but is not limited to:

- **Comprehensive resource recovery**, the basic premise that the project footprints should be minimized by recovering all values, including co- and by-products and eco-system benefits
- **Circularity and Integrated materials flow**, to include all actions to ensure raw materials remain within the boundaries set by the requirements of “reduce, reuse, recycle.”
- **Zero harm and zero waste**, the movement towards maximization of safety for the people and the environment and elimination of all wastes
- **Social Licence to Operate**, the ongoing acceptance of standard business practices and operating procedures by its employees, stakeholders, and the general public.

Although the crucial roles of resource efficiency, circularity and waste minimization are well studied and reported, a comprehensive set of tools to implement these objectives is lacking. For a discernible impact, transformative policies are necessary but not sufficient. When it comes to implementation at ground level more is required connecting policy objectives to operational realities.

The objectives for sustainable development enumerated above clearly requires a systems approach, which should also be anchored at the operational levels of a project. While policy objectives are understood at the top-level, there is a need for a mechanism that drives the projects forward. To find answers to who, what, when, where, why and how the resources should be managed at an operational or project level needs a flexible systems framework.

UNRMS is proposed as the instrument capable of linking policy objectives seamlessly to project implementation. Such a toolkit is currently not available and persistent underperformance in supporting policy objectives to practical results witnessed across the planet can in a significant measure be attributed to this gap.

In other words, a new, SDG-oriented resource management tool kit is required to implement sustainable development, which should be capable of linking the top-down policy directions and bottom-up project implementation in a coherent manner.

## 2.4 THE ESSENTIAL LINKAGES TO RESOURCE MANAGEMENT

The Food – Water – Energy (FEW) nexus integrating the security, accessibility and affordability of essential resources for each individual - in effect, a summary of Maslow’s essential needs hierarchy<sup>29</sup> - underpins the sustainable management of resources with the Agenda 2030 framework. Seen in another manner, meeting the

<sup>28</sup> Collins, J. C., Collins, J., and Porras, J. I. (2005). *Built to last: Successful habits of visionary companies*. Random House.

<sup>29</sup> Maslow, A.H. (1943). *A theory of human motivation*. *Psychological Review*. 50 (4): 370–96.

FEW requirements comprises the sum total of delivering the critical natural resource base itself (see Figure 3). Sustainable resource management does not just support the security of FEW; the raw materials are likewise embedded in the FEW triad. The resource management toolkit should be capable of parsing the complex networks of the FEW space, determining gaps (unmet needs), and guiding decision and policymakers as to how to fill them.

UNRMS will build on the experience of applying UNFC, which classifies resource inventories into various classes depending on three primary criteria, socio-economic viability (E), technical feasibility (F) and level of knowledge (G). UNFC thereby provides a uniform terminology and classifies resource-related information into projects based on the combination of the criteria as above and produces accounts of them based on decisions taken.

UNRMS will harness the unique advantages of UNFC to transition from current accounts to support decisions for potential new developments and hence to provide support for resource progression (e.g. how does a project move from UNFC class E2F2 to E1F1). UNRMS thus will have UNFC at its core and will have additional documentation on how sustainable development of resources could be implemented. UNRMS can also be deployed to channel feedback on policy fine-tuning and course-corrections that will be required to optimize outcomes over the longer-term, especially for projects that have an implication on inter-generational justice.

## 2.5 PRINCIPLES, MEASUREMENT AND MANAGEMENT

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.

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 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”.

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

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. Thus, SDG 12 defines the purpose of UNRMS, which is sustainable resource management. 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.

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 also 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”.

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 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.

Among the principles that might apply to resource management is that it express a:

1. Set of shared values, derived from the ethical “natural justice” position of Agenda 2030, as to how growing prosperity from natural resources is to be achieved;
2. Transparent provenance and purpose for recovered natural resources with full supply-chain traceability;
3. Clear, compelling communications plan as to how prosperity from natural resources may be delivered, based on a "map" of immediate, direct and indirect stakeholders;
4. Commitment to:
  - a. Comprehensive and integrated resource recovery;
  - b. Valorization (reuse, recycling) of secondary resources/ residues;
  - c. Zero waste – Zero harm;
5. "Constructive regulation"<sup>30</sup> framework allowing operator, policymaker, investor and regulator, for the common good, to collaborate on key technology-selection and operational decisions;
6. Description of how the social licence to operate<sup>31</sup> affects, even determines, successful resource progression and adds value;
7. Clear and transparent contractual and governance framework;
8. Policy of equitable distribution of benefits;
9. Local content policy anchored in building local capabilities and socio-economic, resilience; and
10. A clear vision of how to foster and apply investment in innovation, such as in “digital mining” – the application of smart, next-generation processing power and Artificial Intelligence (AI) to the optimization and/or disruption of procedures for resource evaluation, recovery and management.

## 2.6 FUNDAMENTAL PRINCIPLES OF SUSTAINABLE RESOURCE MANAGEMENT – A PROVISIONAL VIEW

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 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.

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<sup>30</sup> Hilton, J., Birky, B., Johnson, A.E., (2008), The ‘constructive regulation’ of phosphates and phosphogypsum: A new, evidence-based approach to regulating a NORM industry vital to the global community, Proceedings, IRPA 12, Buenos Aires.

<sup>31</sup> Mining Minerals and Sustainable Development, (2002) Breaking New Ground. The Report of the MMSD Project, 454 p., London, Earthscan Publications Ltd.

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<sup>32</sup> 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.

Such an approach is in alignment with the ISEAL Standard-setting Code<sup>33</sup>, which defines how a standard should be developed, structured and revised. It requires multi-stakeholder consultation and decision-making and ensures transparent and auditable conditions in the standard itself. Moreover, the Equator Principles<sup>34</sup>, adopted by financial institutions, for determining, assessing and managing environmental and social risk in project finance, and industry standards such as the Global Tailings Standard<sup>35</sup> and the draft Responsible Steel Standard<sup>36</sup> follow this approach. Also, the Certification of Raw Materials (CERA), for ensuring environmental, social and economic sustainability in production, processing, trading and manufacturing can be considered here. CERA is a neutral and independent certification standard for raw materials and international benchmark for the supply chain management<sup>37</sup>.

The fundamental principles of sustainable resource management are listed below. These principles are provisional at this stage and will be firmed up as UNRMS is developed through pilot studies.

## **Principle 1: State rights and responsibilities in the management of resources**

***States (governments) shall have rights and legal and regulatory responsibilities for the resources located on their territory.***

***Explanation:*** *The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet, now and into the future. At its heart are the 17 Sustainable Development Goals (SDGs), an urgent call for action by all countries to manage the resource sustainably. The state has sovereignty over all resources located on its territory. It has independent legislation and full rights to manage and use the resources sustainably. The principles of good governance provided in UNRMS may be applied by States on the principle of voluntariness.*

*States (governments)<sup>38</sup> have a dominant role in the production and consumption of resources. States usually take a long-term view in weighing the costs and benefits of the various measures. The state establishes policies for resources through different instruments, statutes and laws. State reinforces the roles and capacities of resource management agencies such as ministries, regulatory entities, geological surveys and universities.*

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<sup>32</sup> See Yong Geng, Joseph Sarkis and Raimund Bleischwitz (2019) Globalize the circular economy, *Nature*, V565, pp 153-155.

<sup>33</sup> ISEAL is the global membership association for credible sustainability standards. See <https://www.isealliance.org/about-iseal/who-we-are>

<sup>34</sup> See Equator Principles <https://equator-principles.com/>

<sup>35</sup> See Global Tailings Standard: [https://globaltailingsreview.org/wp-content/uploads/2019/11/EN-Global-Tailings-Standard\\_CONSULTATION-DRAFT.pdf](https://globaltailingsreview.org/wp-content/uploads/2019/11/EN-Global-Tailings-Standard_CONSULTATION-DRAFT.pdf)

<sup>36</sup> See Responsible Steel Standard Version 1.0 [https://www.responsiblesteel.org/wp-content/uploads/2019/11/ResponsibleSteel\\_Standard\\_v1-0.pdf](https://www.responsiblesteel.org/wp-content/uploads/2019/11/ResponsibleSteel_Standard_v1-0.pdf)

<sup>37</sup> See Certification of Raw Materials (CERA) standard: <https://www.cera-standard.org>

<sup>38</sup> States have different legal structures, and therefore the term 'State' as used in a broad sense and is accordingly interchangeable here with the term 'Government'.

## Principle 2: Responsibility to the planet

***The primary responsibility of sustainable resource management shall be the continued well-being of the earth, its inhabitants, and the environment.***

**Explanation:** *The principle of environmental limits to sustainable development is recognized in the Brundtland Commission Report (1987) and reflected in Agenda 21 (1992), the Rio Declaration (1992), the Millennium Development Goals (2000) and the Sustainable Development Goals (2015). Brundtland Commission Report (1987) says, “the concept of sustainable development does imply limits - not absolute limits but limitations imposed by the present state of technology and social organization on environmental resources and by the ability of the biosphere to absorb the effects of human activities. At a minimum, sustainable development must not endanger the natural systems that support life on earth: the atmosphere, the waters, the soils, and the living beings.”*

*Sustainable development can be defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable development also means considering the balance of costs and benefits to society and the planet. Resource production and consumption could have adverse impacts. Therefore a sustainable balance between the advantages and the disadvantages needs to be found.*

*The Paris Agreement on Climate Action (2016) says, “climate change is a common concern of humankind”. The Paris Agreement central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius.*

*Primary responsibility to the continued well-being of the planet is also the core of the Equator Principles, a framework adopted by financial institutions to assess and manage environmental and social risks.*

## Principle 3: Integrated and indivisible management of resources

***Sustainable resource management shall be undertaken within the framework of public, public-private and civil society partnerships in an integrated and indivisible manner consistent with its social, environmental and economic viability and systems and a full lifecycle view.***

**Explanation:** *The Brundtland Commission Report (1987) highlighted the integrated nature of natural resources. The report says, “until recently, the planet was a large world in which human activities and their effects were neatly compartmentalized within nations, within sectors (energy, agriculture, trade), and within broad areas of concern (environment, economics, social). Yet, in the end, sustainable development is not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with the future as well as present needs. Yet, most of the institutions facing those challenges tend to be independent, fragmented, working to relatively narrow mandates with closed decision processes. Those responsible for managing natural resources and protecting the environment are institutionally separated from those responsible for managing the economy. Many of the environmental and development problems that confront us have their roots in this decoupling of responsibility. Sustainable development requires that such fragmentation be overcome. The real world of interlocked economic and ecological systems will not change; the policies and institutions concerned must. The ability to anticipate and prevent environmental damage will require that the ecological dimensions of policy be considered simultaneously as the economic, trade, energy, agricultural, and other dimensions.”*

*The language of the 2030 Agenda highlights the need for interconnected thinking between the natural and social sciences and between the research community and decision-makers. The 2030 Agenda says that “the SDGs are integrated and indivisible and balance the three dimensions of sustainable development: the economic, social and environmental”. The interlinked and integrated nature of the SDGs is crucial in ensuring that the purpose of the 2030 Agenda is realized on time. The need for effective public, public-private and civil society partnerships are included in SDG 17.*

*The Brundtland Commission Report (1987) says, “problems cannot be treated separately by fragmented institutions and policies. They are linked in a complex system of cause and effect”. Natural resources serve as direct or functional inputs for socio-economic systems of provision, either for the production of another input, general production and consumption purposes, or the built environment. Systems thinking suggests that research and practitioners should start from a broader nexus understanding but may well focus on specific critical interlinkages across selected layers.*

*Focusing on resources, economic sectors, or different environmental or human impacts as individual silos will not encourage progress towards improved resource use or, more broadly, the achievement of international agreements and the SDGs. Addressing one area without consideration of the others may even have negative consequences. A systems approach is crucial to maximize benefits across sectors and mitigate trade-offs from natural resource use.*

*The systems approach to environmental policy development and implementation can address multiple global goals and is no longer an option but is the only way forward for a societal transformation to achieve global sustainability.*

*Life cycle management of resource stems from the systems approach. Life cycle analysis is a technique to assess the environmental impacts associated with all the stages of a product’s life – from raw materials production through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling (cradle-to-cradle).*

## **Principle 4: Social contract on natural resources**

***Sustainable resource management shall ensure obtaining and keeping the social license to operate.***

***Explanation:*** *Respect human rights, and the interests, cultures, customs and values of employees and communities affected by resource production is an integral part of sustainable resource management and are stressed in the United Nations Guiding Principles on Business and Human Rights. Such an approach will need to pursue continual improvement in social performance and contribute to social, economic and institutional development. Resource management needs to engage key stakeholders on sustainable development challenges proactively. It should also consider opportunities and transparently report and independently verify progress and performance.*

*Sustainable resource management can also have complex social impacts related to displacement, land rights, cultural heritage, indigenous peoples, gender equality, employment, public health, safety and security, sexual exploitation and abuse, and other issues. Rights-based social safeguards, inclusive dialogue and risk management principles should be applied to resource projects to ensure that it benefits the poor, leaves no one behind, and respects human rights. Chief among these is the need for inclusive, participatory, transparent, and ongoing stakeholder consultation to be built into infrastructure planning processes.*



*Sustainable resource management should be based on free, prior and informed consent, in line with the UN Declaration on Indigenous Peoples' Rights. Several SDG targets reinforce the above views, such as SDG 1.4 and 16.7.*

## **Principle 5: Service orientation**

***Resources shall be produced primarily as a service to society.***

***Explanation:*** *The decoupling of natural resource use and environmental impacts from economic activity and human well-being is essential in the transition to a sustainable future. Achieving decoupling is possible and can deliver substantial social and environmental benefits, including repairing past environmental damage while supporting economic growth and human well-being. Service orientation is a core principle that facilitates this decoupling.*

*Service orientation departs from the narrow and restricted commodity-view of resources hitherto followed by industry. There is a growing recognition that the industry primarily exists to “serve” customers, employees, suppliers, and communities. It is only through that service perspective that the industry can create long-term value for shareholders and society.*

## **Principle 6: Comprehensive resource recovery**

***Sustainable resource management shall facilitate and support the knowledge-base and systems for comprehensive recovery of value at all operation stages.***

***Explanation:*** *Comprehensive resource recovery, the idea that the environment should be disturbed minimally by the recovery of all possible values, with a full life cycle focus on a set of priorities, shall be one of the core propositions of resource management. The principle can be expanded to all life cycle stages, where tangible and intangible values should be captured and utilized. Comprehensive resource recovery is also one of the core principles that can contribute to resource use and development decoupling.*

## **Principle 7: Circularity**

***Sustainable resource management shall facilitate and support the knowledge-base and systems for responsible design, use, reuse, recycling and minimization of wastes at all stages.***

***Explanation:*** *A circular economy is a systems approach to industrial processes and economic activity that enables the resource to maintain its highest value for as long as possible. Critical considerations in implementing circularity are reducing and rethinking resource use, the pursuit of longevity, renewability, reusability, reparability, replaceability and upgradability for resources and value-added products.*

*Sustainable resource use requires sound management of renewable resources. It should aim to recycle the non-renewable resources that lend themselves to reuse, leading to the concept of a circular economy in which waste is minimized. The by-product of a process becomes a raw material for another process. In a circular economy, efficient use of resources across their entire life cycle is critical: from production to manufacturing, through consumption and use, to recycling and reuse. Circularity is also key to the decoupling of resource use and development.*

*The Brundtland Commission Report (1987) says “all countries need to anticipate and prevent these pollution problems, by, for instance, enforcing emission standards that reflect likely long-term effects, promoting low-waste technologies, and anticipating the impact of new products, technologies, and wastes.” Sustainable resource management will need to focus on the conservation of all resources employing responsible*

production, consumption, reuse, and recovery of all products, packaging, and materials, without burning them to the extent possible and without discharges to land, water, or air that threaten the environment or human health. This requirement is also vital for the attainment of the SDGs.

## **Principle 8: Health and safety**

***Sustainable resource management shall facilitate and support the knowledge-base and systems that pursue continual improvement in health and safety performance with the ultimate goal of zero harm as reasonably achievable.***

***Explanation:*** Maximization of safety for workers and local populations is integral to International Labour Standards on Occupational Safety and Health<sup>39</sup> and other international conventions. Resource management can be practical and implementable only if the basic concept of safety is given the highest priority in all life cycle stages.

## **Principle 9: Innovation**

***Sustainable resource management shall facilitate and support the knowledge-base and systems that promote innovation for the uptake of hybrid technologies and diversification in production and use.***

***Explanation:*** The coming together of diverse science streams, technology, and the industry is becoming a reality. Getting out of a state of lock-in is to embrace hybrid technologies, diversifications and smart approaches. This principle is acknowledged in the 2030 Agenda, in its call to “achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value-added and labour-intensive sectors.”

## **Principle 10: Transparency**

***Sustainable resource management shall ensure a public understanding of the transfer of revenues and expenditures will help public debate allowing for an informed choice of sustainable development options.***

***Explanation:*** Open information that can be trusted informs better policy and fuels social license to operate. There has been a record of corruption cases along the value chain of numerous extractive industries. The need to avoid corruption, from the award of contracts and licences to the delivery of services, emphasizes transparency in informing public debate and realistic options for sustainable development. Many governments and public and private organizations have sought to reduce the risk of corruption and ensure revenues are adequately used by improving governance and increasing transparency within the sector. Ultimately knowing who controls and benefits from a resource has been used as the key to fighting corruption and preventing illicit financial flows in all sectors of an economy.

A public understanding of the transfer of revenues and expenditures over time will help public debate allowing for an informed choice of sustainable development options. This requires the disclosure of accurate and verifiable information along the value chain. The appropriate use of natural resource wealth should be a

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<sup>39</sup> <https://www.ilo.org/global/standards/subjects-covered-by-international-labour-standards/occupational-safety-and-health/lang--en/index.htm>



*significant driver for sustainable economic growth that contributes to sustainable development and poverty reduction. However, if it is not managed correctly, it can create negative economic and social impacts.*

## **Principle 11: Continuous strengthening of core competencies and capabilities**

**Sustainable resource management shall ensure continuous strengthening of core competencies and capabilities required for cross-disciplinary research, development, demonstration, deployment and operations.**

***Explanation:*** *Integrated and indivisible resource management requires a cross-disciplinary approach to problem-solving and working in diverse teams. Such an approach goes beyond what is available in traditional education and requires continuous improvement of competencies and capabilities.*



### 3. THE RATIONALE FOR TRANSFORMING THE NATURAL RESOURCE MANAGEMENT PARADIGM

If prosperity is to be achieved and shared equitably, the manner in which we, the people, collectively manage and use the natural resources of the planet will be perhaps of all performance indicators the key for measuring our collective attainment of the 2030 Agenda. Why, how, when and where natural resources are discovered, produced, consumed, recovered and re-consumed, and how these actions and decisions affect our climate, will define more than any other activity whether or not we have succeeded.

Against this background, UNFC, whose origins and purposes long predate 2030 Agenda, but also Our Common Future (1987), sees no alternative but to transform itself to meet the new purposes it is challenged, but also required, by 2030 Agenda to face. Its task is to offer people – whether organized as the Member States or commercial enterprises - a balanced, integrated and comprehensive classification and management system for all the natural resources at their disposition. Transformation is nothing new to UNFC, its most recent reinvention of itself being completed in 2009. This next transformation is already underway. Since 2016, UNFC applies to energy, including oil and gas, renewable energy, minerals including nuclear fuel resources; injection projects for the geological storage of CO<sub>2</sub>; groundwater, and anthropogenic resources such as urban landfills, construction and demolition materials and industrial residues and wastes. Considerations of commercial applications have already led to the recommendation of applying a broader set of projects metrics using the UNFC structure.<sup>40</sup>

This chapter discusses the rationale for framing and guiding natural resource management life-cycle. A classification and management framework for assessing and progressing natural resources is clearly a necessary tool in the SDG delivery toolbox. What attributes must this tool, and the users of the tool, have or perhaps acquire to demonstrate that it has capabilities sufficient to meet the expectations of resource management raised by the SDGs?

This condition of sufficiency may not be fully met (a) solely by a project-based system in its core assumptions and methodology, and (b) if the principles on which resource management are based are not in line with meeting 2030 Agenda goals. In addition, there is a need for a clear and compelling description of what the resource management objectives are, beginning with the evaluation and classification.

#### 3.1 RESOURCE MANAGEMENT AS A TRANSFORMATION AGENT

To enable natural resource management to perform adequately as a tool to aid SDG delivery, it may need to be transformative. This entails that resource management encompasses and enables “balanced, integrated and indivisible” approach to the process of recovering value and progression and converting that value into sustainable prosperity, as envisaged by the 2030 Agenda. This transformation takes the properties and attributes of the natural resource eco-system as a whole as the baseline for resource management. While projects will retain an operational function within this eco-system, sustainability that balances the needs of people and planet in a new Nash-like environmental-economic equilibrium<sup>41</sup>, with equitably-distributed prosperity as the outcome, cannot be achieved unless natural resources are seen as naturally “integrated and indivisible” rather than disaggregated as commodities.

<sup>40</sup> See The United Nations Framework Classification for Resources Applied to Commercial Assessments – draft considerations [https://unece.org/fileadmin/DAM/energy/se/pdfs/egrm/egrm10\\_apr2019/ECE\\_ENERGY\\_GE.3\\_2019\\_7.e.pdf](https://unece.org/fileadmin/DAM/energy/se/pdfs/egrm/egrm10_apr2019/ECE_ENERGY_GE.3_2019_7.e.pdf)

<sup>41</sup> See Nash equilibrium [https://en.wikipedia.org/wiki/Nash\\_equilibrium](https://en.wikipedia.org/wiki/Nash_equilibrium)

In some jurisdictions, specific systems are mandated by law. Hence, there is no suggestion that any existing system does not remain “necessary”, at least for the foreseeable future. But it is equally the case that no existing system is “sufficient” in its current state to meet the needs of SDG delivery and the Paris Agreement.

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#### A. BENEFICIARIES, STAKEHOLDERS AND TANGIBLES

2030 Agenda resolves into three key, indivisible elements - people, planet and prosperity. The premise is that if people and planet are in fruitful and equitable equilibrium, prosperity will follow. In trying to understand better the equilibrium of needs between “people” and “planet” with respect to their consumption of natural resources, the consensus is required on:

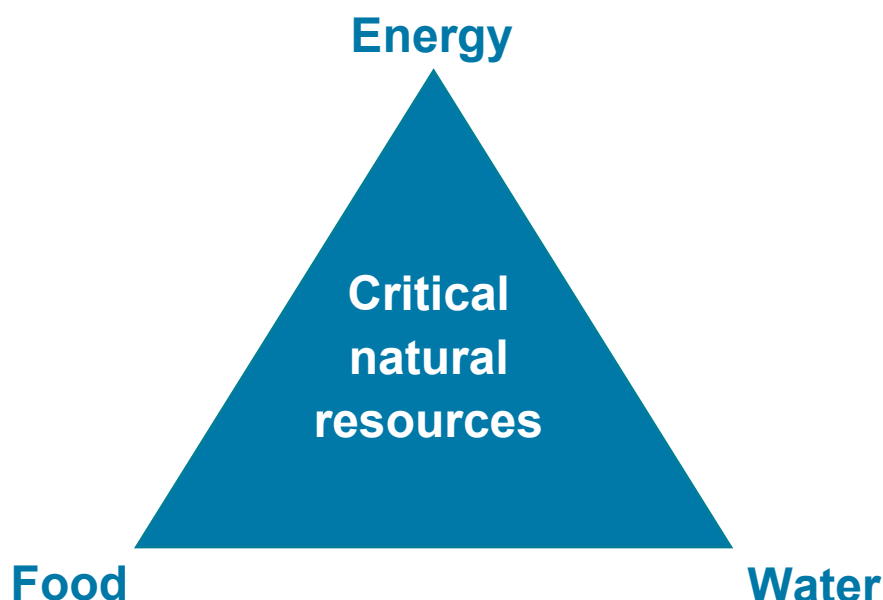
- Who are the primary beneficiaries, and what are their unmet needs or desired outcomes?
- Who are the primary stakeholders and how they relate to, and complement, each other?
- What capabilities and related intangible assets and investment strategies will be required from the stakeholders to meet the needs of the beneficiaries better?
- What combination of tangible assets and both new and existing resources and technologies for recovering and managing them will be required for success?

The primary beneficiaries are assumed to be those people, existing and as yet unborn, whose standard of living and quality of life (i.e. “prosperity”) can be shown to benefit most in value-additional terms from SDG delivery, starting with those with primordial unmet needs of food, energy and water security, affordability and accessibility (Figure 4).

The primary stakeholders are assumed to be:

1. Governments, notably policymakers and regulators;
2. Investors, public, private, institutional and retail;
3. Local communities;
4. Operators, manufacturers and service providers;
5. Educators, academia and researchers;
6. Civil society organizations;
7. Customers and recipients of services; and
8. Future generations.

Figure 4.  
Food, energy and water security as critical natural resources



The requisite capabilities are assumed to be in a state of early-stage definition led by a gap analysis designed to pinpoint where existing capabilities are not fit, or not fully fit, for the successful delivery of the SDGs. The underlying assumption of how such capabilities are to be developed is that imposing the obligation on stakeholders to deliver the SDGs without the requisite capabilities for doing so is not acceptable, breaching the principle of informed consent. Hence, significant investment in capability enhancement through education, training and professional development – which of course the UN can only recommend, not require - is the *sine qua non* both of operational success and to winning the informed consent of beneficiaries to take part.

In respect of tangible assets, there is a clear co-dependency for success in:

- First, understanding the level of confidence that can be attributed to the preliminary evaluations and classifications of primary resources, and subsequently, before resource recovery begins, knowing in detail and with a high level of confidence, what quantities and qualities of resources are available, where they are located and how best, and in what optimal sequence and combinations, they can be recovered and used, to the equal benefit of people and planet and with the outcome of growing prosperity for all;
- Having a clear and compelling narrative to share with beneficiaries and stakeholders as to how alternative recovery process is to be conducted, under what terms of governance and transparency and with what objectives in respect of the distribution of benefits, such that the social licence to operate is negotiated, won and, by continuous dialogue, retained as long as needed;
- Ensuring the safety, sustainability and integrity of the system within which the recovery process is conducted such that to the greatest reasonably possible extent, both primary and secondary resources remain within the boundaries of that system in a “circular” manner that meets the desired end goals of zero harm and zero waste.

While there is as yet no normalised model of what a “circular” economy is, it is clear that a pivot is required from a linear model of natural resource management, characterised as “take/make, use, dispose of” to a “circular” one characterised as take/make, use, retake/remake”. In natural resource management terms, this means shifting from a one-step “extractive” to a continuous “recovery” modus operandi. In terms of materials flows, this likewise means that nothing unnecessarily or unavoidably leaves the boundaries of the eco-system, i.e. there is “zero waste”.

A key test of the success of any resource management system will be its ability to define and manage “new economic resources”. Such resources are generated at the point of convergence between new capabilities (intangibles) and unused or neglected residuals (such as wastes, residues and tailings).

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## B. INTANGIBLES – NEW ECONOMIC RESOURCES

With the pivot from natural-resource to human-resource centred management, the change (transformative) drivers pivot from tangibles, e.g., “extractive” technologies to intangibles. Among these, and in no particular order of significance, are:

1. A sustainable “decoupled” resource policy framework;
2. Reworked policies and good practices for local content for all natural resource projects (see the June 2017 Organisation for Economic Co-operation and Development (OECD) position paper<sup>42</sup>;
3. Development of innovative competencies/ capabilities with enhancing productivity in mind, but also transferability of capabilities from one resource to another to enhance sectoral resilience, based on multidisciplinary project teams, led perhaps by specialist Natural Resource Managers;
4. Excellent communications:
  - a. Inside teams
  - b. Between operators and investors/ financiers
  - c. Between all stakeholders;
5. Reframing the product offering around the paradigm of raw materials as a service;
6. Application of smart systems and artificial intelligence to the natural resource cycle;
7. Adoption of comprehensive resource recovery policies for all resources, with priority given to co- and by-product sources for any mineral, as part of “all-in sustaining cost” financing;
8. A renegotiated social licence to operate for all recovery programmes based on shared values, a transparent, ethical position regarding risks and benefits and a compelling new narrative;
9. Delivery of sustainable development goals, high efficiencies and zero waste.

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## C. FROM PROJECTS TO INTEGRATED RESOURCE MANAGEMENT

The intangibles refocus the objectives of resource management away from mechanically or chemically based, project-specific, “extractive” processes such as hydro- and pyro-metallurgy towards informatics-based systems for exploring, assessing and managing natural resources in a smart, integrated manner. This refocus means moving away from single-target “projects” towards programmatic, “eco-system” portfolio management techniques applied to combinations of a resource such as found in resource basins containing oil, gas, coal, phosphates, uranium, rare earth, water, forest and other resources such as renewable energy and anthropogenic resources.

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<sup>42</sup> Organisation for Economic Co-operation and Development Trade and Agriculture Directorate Trade Committee, (2017) Local Content Policies in Minerals-Exporting, Part 1, Paris.



This change of approach towards integrated eco-system management programmes depends critically on exploiting inexpensive ever more powerful processing capability, starting from defining technology gaps and shortcomings and then filling them. This, in turn, enables:

- The development of new capabilities, whether human, artificially intelligent or both, *that*
- Trigger innovative business models  
*that*
- Target TBL outcomes  
*in which*
- The interests of people, planet and prosperity are aligned.

Put another way this pivots resource management away from a conventional, natural-resource (oil, gas, minerals, water, soil, etc.) centred to a more integrated human-resource centred model, fully in line with the original Brundtland sustainable development model, i.e., designed to meet the needs of both present and future generations.

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#### D. FROM LINEAR TO CIRCULAR

When “resources” per se are re-centred in this manner around human resources, and their capabilities, knowledge and technologies, the production and utilisation of natural resources become a “regenerative” activity - in some cases even “circular” - rather than linear and “extractive” as seen and practised today. This re-centring, of course, presupposes, as the SDGs do that generations wish to collaborate forward through time (diachronically) and not just in time (synchronically). If it is agreed that they do, even in the case of generations not yet born, then our resource management methodology has to move away from a project-focused “push” model of resource use premised on “extracting” value” to one that is driven by defining the “pull” of meeting predicated future generational needs.

Once these future needs are predicated, the pathway to that future can be charted by working back from them (reverse induction) to our current state. Such predictive modelling has no guarantee of success, but it acts as a critical modifier for protecting the interests and freedoms of the yet unborn. Hence the transformative vocabulary of the redesigned resource pathway substitutes the term “recovery” for “extraction”, and a single-resource model is substituted by an integrated, eco-system model.

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#### E. FROM PUSH TO PULL – TRANSFORMATIVE ACTIONS

In line with the transformative process from linear to circular natural resource management, a number of system properties change. Among the more significant are:

- The system baseline is defined by the safe management of secondary, not primary resources, by which primary resources are conserved and – to the extent reasonably possible - only accessed to top up continuously “remade” secondary resources, hence tending, or achieving “zero waste”;
- All natural resources are equally “critical” in nature in respect of the imperative to manage them in an “as efficiently as reasonably possible” a manner, not as a measure of their scarcity or insecurity of supply;
- The concepts of food, energy and water security are assumed indivisibly to vest the attribute “security” with the co-attributes “accessibility” and “affordability”;
- In the efficient, affordable delivery of resources to meet unmet needs time is of the essence. Hence, the “pull” of unmet need becomes the primary driver (demand side) rather than the “push” of commoditised production (supply-side). For the system to be in equilibrium both pull and push stakeholders must benefit;

- The application of a "dual discovery" principle to resource exploration and classification, by which is meant using a sequence of actions to discover values, irrespective of whether the target is one or many. First, discovery is made in the natural environment, which is what a conventional exploration programme does. The current paradigm is that this is the discovery point for a new "source", which could be eventually converted into a "product". Additional value could be discovered subsequently in a second or full discovery phase – such more co-products (e.g. value from wastes), services (e.g. increased agricultural productivity in the nearby area by providing innovative low-analysis soil amendments from processing residues such as red mud and phosphogypsum etc.) during the scoping-, pre- and feasibility study phases. The current thinking of "conversion of sources into products" assumes only a small, mostly linear selection of a subset of pre-existing materials.

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## F. INNOVATION FROM PUSH TO PULL

The transformation from linear “push” to circular (continuous recovery) pull refocuses attention for meeting sustainable development goals on identifying and characterising technology gaps and shortcomings, viewing these as surmountable challenges, or unmet needs, rather than limitations, and innovating affordable techniques and technologies for doing so.

In this, resilience and innovation (SDG 9) are key. Innovation means sometimes doing better, sometimes doing different, sometimes resetting completely the point of equilibrium from which the properties of the system as a whole derive. Whichever strategy is followed, enhanced resilience results as a value-add. Resource management, therefore, needs to refocus on encouraging resource progression through innovative business models that can discover a “cluster of values” simultaneously applicable across a range of SDGs, so building prosperity in an “eco-system service” model. This will drive resource management in a different direction altogether from the current “commodity” model.

The benefit, in general, is that it can operate as a tool for dual, or even continuous, discoveries across the whole resource life cycle. For example, the initial discovery of energy or material in place may lead to a subsequent discovery and /or design of a set of values in its production and utilization pathways. A combination of AI and human tools may, for example, be able to evaluate all available materials in an economical transport radius against societal needs and production technologies.

Making the change from push to pull brings with it many risks, of which one, in particular, is perhaps the most severe for successful (prosperous) resource management. This is the risk of an asymptotic gap opening up between what is in principle possible for modern Industry 4.0<sup>43</sup> resource recovery to accomplish and what is done. That such gaps can open up quickly and with highly damaging consequences by arbitrarily restricting social and economic growth for reasons of vested interest, is not as such a new phenomenon.

In resource project terms, the time it takes from discovering a new resource to successfully recovering it on a commercial scale is now commonly 25 years or more, i.e. it takes a whole generation to transition from discovery to recovery. In terms of processing power and wider processing capability, according to Moore’s law between 10 and 15 technology life-cycles will have elapsed in the same period. What has happened as a result is that resource recovery and resource management timelines have started to diverge at an alarming rate and the gap between what could be done and what is done is at risk of the asymptote.

Perhaps artificial intelligence (AI) can function as the adaptive bridge that crosses this asymptotic chasm? If so, it has to enable reverse engineering from transformative outcomes predicated to be reached at increasingly distant future time points. If this can be done, it will enable the development of increasingly

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<sup>43</sup> The Fourth Industrial Revolution or Industry 4.0, is the ongoing transformation of traditional manufacturing and industrial practises combined with the latest smart technology.

powerful exploration and discovery tool that can be applied to specifying programmes for sustainable and integrated resource management. These can be used to complement, or even modify, existing tools for increasing productivity and enhanced return on investment (ROI) from recovering existing resources.

The objective would be to create new economic resources from integrated natural resource recovery in ways we never thought of as possible before, stimulating innovation in breakthrough technologies to achieve such outcomes. Such ambitious approaches have disruptive attributes perhaps but are best characterised as disruptive because they do not displace anything that currently exists with something new.

The consequences for the operation of resource management could hardly be more profound. In regard to technology, levels of recovery, accuracy and efficiency are now achievable that even ten years ago would have been impossible, such that significantly lower avoidable losses and leakages from source to end-use and reuse can be confidently predicted.

The capital intensity of many of the current industry-standard technologies in use may delay the introduction of such tools and techniques for socio-political reasons. The very concepts of how a “source” is defined and then how it becomes a “product” are being redefined as traditional key metrics such as cut-off grades of even internal rates of return must change.

The impact of the digital revolution is so profound that it has become imperative, within the framework of constructive regulation<sup>44</sup>, to find a sustainable way to redesign the resource recovery pathway and toolkit to bring it into synchrony with a forward-looking resource management system. Resource management should operate within the constructive regulation space because it rests on a voluntary alignment of interests between government, regulators, operators, finance and academia – i.e., it illustrates well SDG 17. It must, however, articulate this objective in an explicit manner rather than leave it unsaid.

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## G. TECHNOLOGY OPPORTUNITIES AND DISRUPTERS

The world is in the midst of a digital transformation. This transformation is embracing all facets of the society, but more so the industry. In a nutshell, this structural transformation is also about embedding information and knowledge in all activities of the society and making the activities specialised in a manner different from the past. Smart machines, robotics and artificial intelligence, are appropriating traditional specialisations, while the human capability is being challenged to an exceptional level of generalisation not seen in the past.

In the past specialisation of human activities made resource management simpler. Today, human capabilities need a level of “T-shaped specialisation”<sup>45</sup> than can see inter-connections, linkages and new patterns. There is a need to “unlearn and re-learn” the resource value-chain. The rise of intangibles, the drive from “extraction” to new economic resources, often characterised by capabilities, communications, seeing materials as a service, and developing a robust social licence to operate are some of the examples.

Industry 4.0, hoisted to a large extent on the wake of artificial intelligence and machine learning, will have a more profound impact on the resource development industry. This will span to broader areas of cross-sectoral linkages, hybridisation of technology and processes and widespread disruptions.

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<sup>44</sup> The goal of constructive regulation is to achieve a new, sustainable equilibrium for the future, balancing public health and safety requirements with the need to maintain a viable and affordable global production capacity for these life-critical resources. This will require new modes of collaboration between industry, regulators and independent centres of scientific research.

<sup>45</sup> A T-shaped employee, in the context of human resources, is an individual who has deep knowledge and skills in a particular area of specialization, along with and the desire and ability to make connections across disciplines.

Building resilience and robustness to business processes is going to consume a lot of attention in the future. An effective player in this scenario will have to fall back on the essential requirements mentioned in the earlier section - consistent data, information and knowledge.

Of the primary transformational agents for future, sustainable natural resource management one is intangible, the other tangible. The intangible is the policy – vision perhaps – of zero waste and valorisation of secondary resources. The tangible is the digital revolution.

More powerful, smarter, artificially intelligent processing power is necessary to create a viable and prosperous 4.0 industrial eco-system based on integrated resource management and value-additive materials flows. But only by adopting the voluntary constraint of zero waste will the systemic change required to achieve the SDGs change the culture of resource management to a sufficient degree to transform it.

While hitherto technology limitations were seen as constituting an insurmountable barrier to transforming the natural resource management culture, the digital revolution - underpinned for many years by Moore’s law, by which processing power continues to double every 18-24 months while simultaneously halving in the price - makes breaching this barrier a distinct possibility. Perhaps processing technology has already advanced to a point where the next quantum leap in computing technology may shift the burden from human vision with computer-assisted management to human/AI vision with computer management.

That is, efficiencies that are unattainable in human terms alone will make full secondary resource valorization and zero waste viable goals. Some of the many consequences of the barrier coming down – summarised as the pivot from “push” to “pull” - are set out in Table 4.

It is, however, already clear that this revolution has risks and costs associated with it not just potential benefits. Some mining and processing companies report that they have invested heavily in new “smart” systems only to find that operators have the habit of either over-riding or misinterpreting the data generated by these systems with the result that accuracy and productivity reduce rather than increase, with a consequent negative impact on operating margins. In commoditised industries where margins are already under significant pressure, the results in respect of financial outcomes can be very costly.

Perhaps AI techniques can be used to “design in” or embed forms of intelligence into such operating systems that user over-rides can be quickly detected and evaluated. Perhaps the role of the operator as hitherto understood will completely change?

**Table 4.**  
**Energy and mineral resources as an example of SDG delivery by “Pull.”**

<i>Push</i>	<i>Pull</i>	<i>Drivers</i>
Energy and minerals resources as commodity	Energy and minerals as service	New business models
Energy and mineral resources for sustainable development-	Clean energy and minerals (such as REE and Li) in keeping the 2°C secondary target on track.	Transformative technologies, AI
Extract it, and they’ll trade it	Minerals in the ground, available on demand	UNRMS-based new resource management
Single target resource/ Single purpose	Integrated resource management (comprehensive resource recovery)/ Integrated purpose: e.g. whole [energetic] basin	New economic resources Zero waste Integrated flowsheets

Technology selection output driven	Technology selection, including digital/ AI, outcomes-driven	Constructive regulation Transformative technologies, AI
Negative externalities and safety managed by “defence in depth” (tailing dams etc.)	Reuse and recycling Only positive outcomes, safety in design	Waste hierarchy transformative technologies, AI
Fixed marginal cost of producing additional units	Nudge economics Zero marginal cost of production	Transformative technologies, recombination of technologies, AI
“Rival” goods and commodities	“Non-rival” services	Transformative technologies, recombination of technologies, AI
Operate through fixed value-chains (provider-customer relationships)	Operate through flexible platforms (providers and customers are interchangeable)	New platforms, AI
Productivity stagnation	Productivity growth	AI
Projects tangibles driven	Programmes, intangibles-driven – capabilities, values, communications, ethics	UNRMS based new resource management
Risk assessment in isolation	Risk/risk assessment (risk of doing vs the risk of not-doing)	Constructive regulation
Extensive - high footprint land/ marine use	Intensive – High-intensity low footprint land use	Land use priorities New technologies
Waste inevitable/negative externality (waste ejected outside system boundary)	Secondary resources (waste retained inside system boundary)	Zero waste New technologies, AI
Specialized skilled and unskilled jobs	Productivity enhanced jobs/ diminish routine and repetitive tasks	New industry curriculum
Linear economy - Make-use-dispose	Circular economy: Make - use - remake	New technologies, AI
Market – win/lose	Nash-Stackelberg equilibrium win/win	Cooperative game strategy
Primary resources main system driver	Cluster of resources main system driver	New Business Models

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## H. CHARTING THE NEW NORMAL WITH 21<sup>ST</sup> CENTURY TOOLS AND TECHNOLOGY

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.

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,<sup>46</sup> 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”.

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 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.<sup>47</sup>

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.

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.

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.<sup>48</sup> Use of AI in renewable energy production is another exciting development.

### 3.2 SYSTEM OF ENVIRONMENTAL-ECONOMIC ACCOUNTING

Encouragingly, other tools like the System of Environmental-Economic Accounting which can be applied to SDG delivery, and which align well with the current direction of travel of UNFC are already a little further down the transformational path. The intangible, transgenerational benefit of increased prosperity, which flows from aligning the interests of people and planet sustainably, is anticipated in SEEA<sup>49</sup>. SEEA, which emanates from the

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<sup>46</sup> See Artificial intelligence could help to detect breast cancer <https://www.nihr.ac.uk/news/artificial-intelligence-could-help-to-detect-breast-cancer/23492>

<sup>47</sup> See Human Vaccine Created Solely by Artificial Intelligence <https://www.docwirenews.com/docwire-pick/human-vaccine-created-solely-by-artificial-intelligence/>

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

<sup>49</sup> United Nations, European Union, Food and Agriculture Organization of the United Nations, International Monetary Fund, Organisation for Economic Co-operation and Development, World Bank, (2014) *System of Environmental-Economic Accounting 2012— Central Framework*, New York.



UN Statistical Division, World Bank, the International Monetary Fund and OECD is of course, fundamentally concerned with economic development - prosperity.

The SEEA Central Framework is an international statistical standard for measuring the environment and its relationship with the economy. The Central Framework covers measurement in three main areas:

1. **Environmental flows.** The flows of natural inputs, products and residuals between the environment and the economy, and within the economy, both in physical and monetary terms.
2. **Stocks of environmental assets.** The stocks of individual assets, such as water or energy assets, and how they change over an accounting period due to economic activity and natural processes, both in physical and monetary terms.
3. **Economic activity related to the environment.** Monetary flows associated with economic activities related to the environment, including spending on environmental protection and resource management, and the production of 'environmental goods and services.

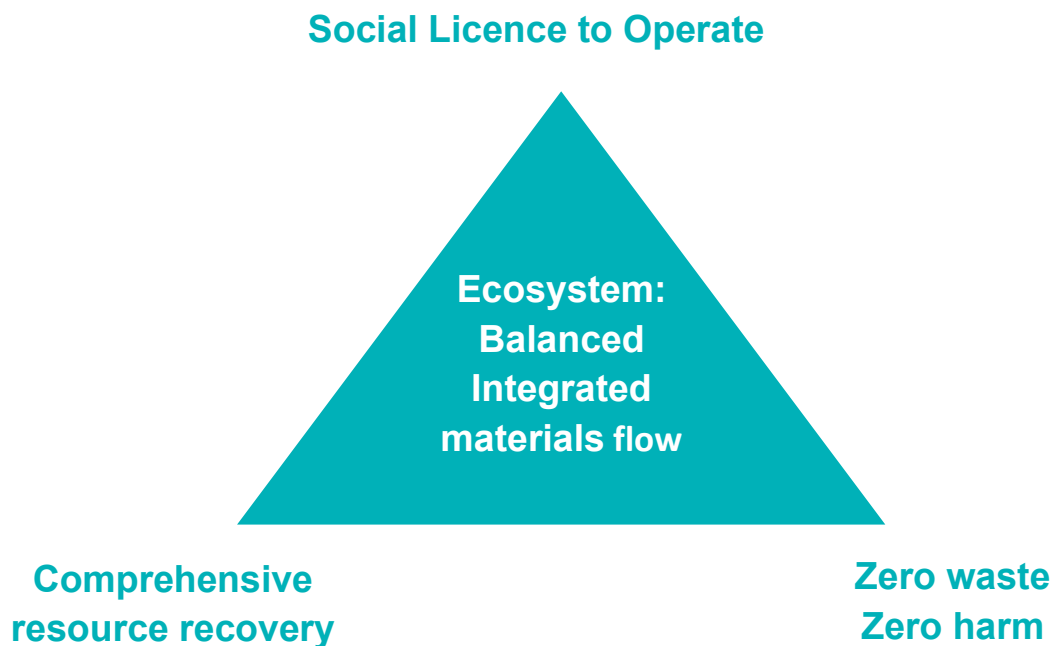
While it predates the adoption of the SDGs, it explicitly shares a common lineage with them from the original 1987 Brundtland statement of the nature and goals of Sustainable Development and is designed to promote sustainability and wealth creation. In that sense, its founding assumptions are fully consistent with the SDGs and its particular emphasis on "value release from residuals" aligns perfectly with the rapidly emerging adoption of "zero waste" policies in natural resource management of all kinds.

Like the way the 2030 Agenda is framed in a linguistically and conceptually transformative manner, not the least of the remarkable attributes of SEEA is (a) its hyphenation of two of the TBL adjectives, and (b) the order in which it hyphenates them, "environmental-economic". This simple act of coupling creates a new, Nash-like point of equilibrium in the integration of environmental and economic measures of return, which sets the syllogistic first principle from which a resource management system can be derived, drawn and applied.

From a significant range of discussions, four "zero-conditions" for sustainable natural resource management (Figure 5) have crystallised. These are:

1. Comprehensive Resource Recovery (CRR)
2. Circularity and Integrated materials flow
3. Zero Waste (OW)/ Zero Harm (OH)
4. Social Licence to Operate (SLO)

**Figure 5.**  
**Four zero conditions for a sustainable natural resource management ecosystem**



As SEEA expresses it, the primordial characteristic of the eco-system is balanced; integrated materials flow: “Physical [materials] flow accounts”, explain in detail the recording of physical flows. The different physical flows—natural inputs, products and residuals—are placed within the structure of physical supply and use [eco-system]; and from this starting point measurement of the [materials] flows can be expanded and reduced to enable focusing on a range of different materials or specific flows”.

An ideal resource management system should be able to identify all developed and undeveloped projects and their maturity towards operation and production of the desired outputs. It should be able to identify the key attributes of the social, environmental and economic viability of each project.

Such a system should also be able to identify how the projects connect to the sustainable development programme, be it at a facility, company, national or regional levels. The system should make the linkage of a company vision, and the project attributes visible. The same is true for national or regional policies and priorities and nodes that connect to a large number of projects. The 2030 Agenda is a good example. How a project relates to the SDGs is not just restricted to a few measures such as fuel efficiency or emissions control but needs to be firmly linked to all the 169 targets.

The system should be capable of quantifying or describing the performance of the project for each of the key attributes qualitatively. It should provide standards and guidance to the project implementors on key aspects of good governance, such as:

- Core Competencies and capabilities
- Implementation (including local content)
- Innovation to overcome challenges
- Zero waste
- Zero harm

- Estimation of volumes and forecasts
- Documentation
- Analysis of results.

UNRMS will look to aid in replotting the economics of resource management in a balanced and equitable manner, grounded in SEEA, which is in turn firmly grounded in Nash’s economic theory.

The first step in the direction of integrating SEEA principles within UNRMS has been taken by UNFC itself through it not only classifying multiple resources but also secondary as well as primary resources. Once taken, that step leads naturally to managing these resources and resource combinations in a balanced and integrated matter within UNRMS.

In summary, an ideal resource management system is all about integrated resource management, not just reporting of volumes or quantities, and discerning the links to the sustainable development programme.

### 3.3 TRANSFORMING OUR WORLD THROUGH INVESTMENT

Share Action, responsible for USD\$5.9 trillion, approximately one-sixth of the total pension fund investments of the world, with members in thirteen countries, has analyzed in detail how to classify and rank the SDGs such that prosperity is the outcome for people and planet. In the landmark 2016 publication, “Transforming Our World through Investment”<sup>50</sup> the SDG 9 is a significant point of departure from the normal world of institutional investment. Perhaps counter-intuitively in this supposedly risk-averse world, Share Action, the “movement for responsible investment” presents itself as both wholly in favour of aligning its investment strategy with the SDGs through investment and ranking the need to meet SDG 9 as in first place in its alignment procedure.

The fund managers rank SDG 9 in the first place as an investment driver – “Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation” – SDG 13 in second place - “Take urgent action to tackle climate change and its impacts” - and SDG7 in third place - Ensure access to affordable, reliable, sustainable and modern energy for all”.

In the emerging model, the future management of all natural resources will be decided by i) innovation, ii) their contribution to climate action and iii) their direct or indirect role as an energy source. Further, as an example of how previously neglected “wastes” such as phosphogypsum can be transformed into valuable secondary resources as part of a conscious investment strategy, 57 per cent of the fund managers rank SDG 15 in fourth place in respect of priorities for investment action, namely measures to combat desertification and halt or reverse land degradation.

### 3.4 BUILDING NEW NARRATIVES AND IMPROVING DECISION-MAKING

Neoclassical economics has shaped our understanding of human behaviour for several decades. While still an important starting point for economic studies, neoclassical frameworks have imposed strong assumptions, for example regarding utility maximization, information, and foresight, while treating consumer preferences as given or external to the framework.<sup>51, 52</sup> Behavioural insights can help policymakers obtain a deeper understanding of the behavioural (demand and supply-side) mechanisms contributing to energy and raw

<sup>50</sup> ShareAction, (2016) Transforming Our World through Investment, An Introductory Study of institutional investors’ role in supporting the Sustainable Development Goals, London.

<sup>51</sup> U.S. Energy Information Administration, (2014) Behavioral Economics Applied to Energy Demand Analysis: A Foundation, Washington D.C.

<sup>52</sup> John M. Gowdy, (2008) Behavioral economics and climate change policy, Journal of Economic Behavior & Organization, 2004, Volume 68, Issues 3–4, pp. 632-644, ISSN 0167-2681, <https://doi.org/10.1016/j.jebo.2008.06.011>.

material issues, and design and implement more effective policy interventions.<sup>53</sup> While most of the focus to date has been on the demand-side, such as conservation and recycling, the whole life-cycle from supply-side included, should be considered in an integrated manner. Efficiency improvement, waste minimization etc. involves all critical points along the value chain.

Succinct narratives could also be developed to improve policy and decision-making, avoiding many of these biases. For example, energy and raw material industries have traditionally used terms such as “extraction” and “exploitation” without understanding their impact on human behavioural responses. Behavioural (“nudge”)<sup>54</sup> and neuro-economics today provide a basis for understanding how human brains construct narratives from existing information, which is usually coloured by many heuristic pitfalls.<sup>55</sup>

The failure to build a common narrative of what the objectives are of equitable natural resource management has put many resource projects at high risk, with both social and economic negative consequences. This narrative failure may not be obvious when social contracts are first negotiated, largely due to the inexperience of one or even both parties. The result is that key reference points, such as clarity concerning stakeholder expectations, are commonly neglected; or there may be no social and environmental baseline data to work from, sowing the seeds of future failure and very expensive write-downs.

Grounding stakeholder engagement in a sound understanding of behavioural economics will increase the chances of a common narrative being created and sustained from a very early stage, enabling realistic, well-accepted energy and raw material policy, making as well as space for generating innovative business models.

### 3.5 THE RESOURCE MANAGEMENT TOOLKIT

Taking into account the growing impact of intangibles in sustainable resource progression, and bearing in mind the pivot from “push” to “pull” management models, focused on current and predicted future needs, without losing its grounding in managing the resources in demand, the toolkit may need to diversify. Different decision-makers may have different interests and options. One such set may be:

- **Resource** centred (life-cycle resource management, primary, secondary, circular, zero-waste etc.)
- **Value and outcome** centred (ending poverty, new economic resources, equitable distribution of benefits, governance, transparency...) (SDG “prosperity” centred)
- **Customer and service** centred (energy and raw materials as service, the right to produce and sell raw materials and energy and/or form local energy communities, inclusive artisanal resource management)
- **Security of supply** centred (maintaining the security of supply for food, energy, water, critical material).

Developing any such extended toolkit will require detailed needs analysis, stakeholder consultation and engagement, and piloting before a robust toolkit, with an associated training and professional development programme can be deployed. The development of this toolkit may require

1. The addition of new criteria and provide greater range, precision and clarity on attributes of both social and environmental licensing considerations;

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<sup>53</sup> Organisation for Economic Co-operation and Development (2017) Tackling Environmental Problems with the Help of Behavioural Insights <http://www.oecd.org/greengrowth/consumption-innovation/behaviour.htm>

<sup>54</sup> Thaler, R.H., Sunstein, C.R., (2008) Nudge: Improving Decisions about Health, Wealth, and Happiness, Yale University Press.

<sup>55</sup> A heuristic is a mental shortcut that allows people to solve problems and make judgments quickly and efficiently. Heuristics are helpful in many situations, but they can also lead to cognitive biases.

2. The ability to evaluate additional information than volumes, as for example, specific SDG goal alignments, such as associated CO<sub>2</sub> emissions (SDG 13), various measures of value (SDGs 8 and 9) or reduced waste (SDG 12); and
3. The capability (skill, capacity and finance) to do the work.

In such ways, the toolkit can assist with SDG compliance through tools which offer clear information and choices concerning the things that matter to each of the stakeholders and beneficiaries.

Taking such steps would be consistent with the principle enunciated earlier in this report that we cannot expect to deliver the SDGs without significant and systematic investment in developing the necessary capabilities to do so. Such capabilities include the ability to challenge and change our perceptions of what we mean by resources in the first place and to execute studies based on this understanding. In the circular economy, much that we have been long-accustomed to call “waste” is transformed, or at least transformable, into secondary resources.







## 4. GLOBAL VALUES, REGIONAL CIRCUMSTANCES, PRIORITIES AND NEEDS FOR RESOURCE MANAGEMENT

**B**alanced, integrated and equitable management of natural resources underpins the timely delivery of all the 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, must 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.<sup>56</sup>

For sustainable resource management, 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 is premised.

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, AI, and other enablers.

### 4.1 CHRONIC AND ACUTE RESOURCE STRESS

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<sup>57</sup>. The study in question was on using the latest satellite imaging technology to map the extent of salinization and desertification of soils worldwide. 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 one 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

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<sup>56</sup> UN Decade of Action <https://www.un.org/sustainabledevelopment/decade-of-action/>

<sup>57</sup> 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.

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.

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,<sup>58</sup> the need can be defined 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.

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<sup>59</sup>. 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.

## 4.2 MORE THAN THE SUM OF THEIR PARTS

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.

Complex systems have distinct qualities that arise from these relationships. 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.

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

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<sup>58</sup> Coronavirus: NHS uses tech giants to plan crisis response <https://www.bbc.co.uk/news/technology-52053565>

<sup>59</sup> See Pandemics result from destruction of nature, say UN and WHO <https://www.theguardian.com/world/2020/jun/17/pandemics-destruction-nature-un-who-legislation-trade-green-recovery>

systems which characterize them. This quality is a crucial indicator that they can give rise to catastrophic public health events. Some examples are acute events such as the COVID-19 pandemic, and chronic events such as the outbreak of HIV/AIDS. Common attributes of such places are high levels of population density, connectivity, biodiversity hotspots, waste and air pollution.

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.

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.

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.

#### 4.3 BLACK SWANS

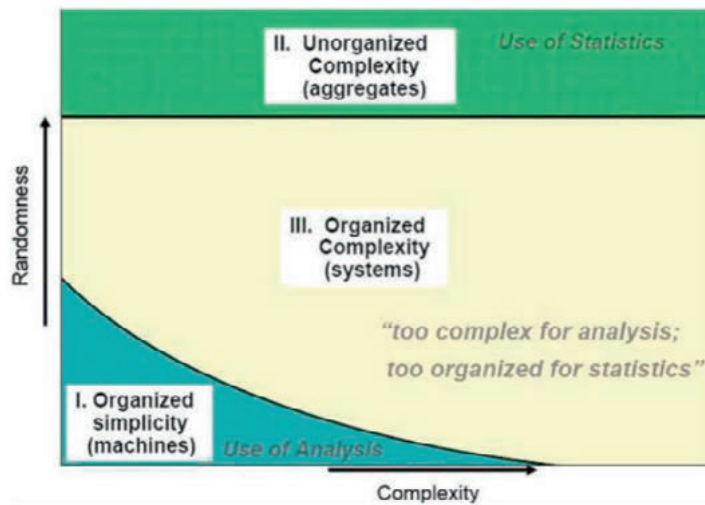
Black Swans are unpredicted, though perhaps not unpredictable, events to which we are systemically vulnerable. Such events arise from a mixture of our inability to predict the future and to retain resilience based on lessons learned from similar past experiences.<sup>60</sup> In systems thinking, the 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 6). The middle region of “organized complexity” may be defined as “too complex for analysis and too organized for statistics”.<sup>61</sup>

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<sup>60</sup> Taleb, N (2007) *The Black Swan: The Impact of the Highly Improbable*, Random House

<sup>61</sup> Weinberg, G (2011) *An Introduction to General Systems Thinking*, Weinberg & Weinberg

Figure 6.  
Complexity versus randomness model showing the region where systems lie



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.

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

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, and 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.

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.

The “genius of the AND” is the alternative win-win strategy, the belief that allows resource management to pursue both A AND B outcomes at the same time.<sup>62</sup> Aligning resource management to this principle is fundamental to the development of UNRMS.

#### 4.4 THE RISE OF STAKEHOLDER CAPITALISM

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.

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.

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.

#### 4.5 ACCELERATING THE DRIVE TOWARDS THE CIRCULAR ECONOMY AND RESILIENCE

It is now evident that the runaway 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, the 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.

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.

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,

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<sup>62</sup> Collins, Jim (2004) Built to Last: Successful Habits of Visionary Companies, Harper Business.

climate change, ocean acidification, freshwater consumption, land system change, nitrogen and phosphorus flow to the biosphere and oceans, atmospheric aerosol loading.<sup>63</sup> Crossing these boundaries increases the risk of generating large-scale abrupt or irreversible environmental changes.

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<sup>64</sup> and medical masks<sup>65</sup> to ventilators.<sup>66</sup>

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.

#### 4.6 REGIONAL CIRCUMSTANCES AND PRIORITIES

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 the management of critical raw material resources in Europe.<sup>67</sup> Several Horizon 2020 projects have work packages to test and implement UNFC as the resource management framework in Europe. EuroGeoSurveys (EGS), the community of European National Geological Surveys is committed to the development of UNFC and UNRMS. The Mineral Resources Expert Group (MREG) of EGS is mapping the interoperability between national datasets and UNFC with the development of many case studies. Nordic countries (Finland, Norway and Sweden) which have developed locally moderated UNFC guidelines for mineral resources.<sup>68</sup> Norwegian Petroleum Directorate (NPD) has been using UNFC since 2014 for classifying about 700 individual petroleum projects and reporting in annual resource accounts.

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<sup>63</sup> See Stockholm Resilience Centre “The Planetary Boundaries” <https://www.stockholmresilience.org/research/planetary-boundaries/planetary-boundaries/about-the-research/the-nine-planetary-boundaries.html>

<sup>64</sup> 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>

<sup>65</sup> 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/>

<sup>66</sup> 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/>

<sup>67</sup> 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>

<sup>68</sup> See Guidance for the application of UNFC for mineral resources in Finland, Norway and Sweden [https://www.unece.org/fileadmin/DAM/energy/se/pdfs/UNFC/2018/UNFC\\_Nordic\\_guidelines/180212\\_A\\_guidance\\_for\\_the\\_application\\_of\\_the\\_UNFC.pdf](https://www.unece.org/fileadmin/DAM/energy/se/pdfs/UNFC/2018/UNFC_Nordic_guidelines/180212_A_guidance_for_the_application_of_the_UNFC.pdf)



UNFC is bridged to the Oil and Fuel Gas Reserves and Resources Classification of 2013 of the Russian Federation<sup>69</sup> and aims to do the same with its minerals system and pilot the use of UNFC in the Commonwealth of Independent States (CIS) region. 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.<sup>70</sup> Other countries in Central Asia and South-East Europe follow similar integrated approaches.<sup>71</sup>

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. The Chinese petroleum<sup>72</sup> and mineral<sup>73</sup> systems are bridged to UNFC. China seeks to support stakeholder institutions involved in resource management in the Belt and Road Initiative (BRI) countries to adapt their approaches in line with the 2030 Agenda to address infrastructure gaps, based on the golden principles of extensive consultation, joint contribution and shared benefits. UNFC supports progress towards data harmonization in China<sup>74</sup> and India.<sup>75</sup>

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 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 Africa Mining Vision (AMV), a UNFC and UNRMS-based African Mineral and Energy Resources Classification and Management System (AMREC) is now developed by the African Union (AU).<sup>76</sup>

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<sup>69</sup> [https://www.unece.org/fileadmin/DAM/energy/se/pdfs/UNFC/UNFC.RF.BD/UNFC\\_RF.BD\\_e](https://www.unece.org/fileadmin/DAM/energy/se/pdfs/UNFC/UNFC.RF.BD/UNFC_RF.BD_e)

<sup>70</sup> 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>

<sup>71</sup> 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>

<sup>72</sup> [https://www.unece.org/fileadmin/DAM/energy/se/pdfs/Comm27/ece.energy.2018.4\\_e\\_UNFC\\_China\\_Petroleum\\_BD\\_FINAL\\_as\\_submitted.pdf](https://www.unece.org/fileadmin/DAM/energy/se/pdfs/Comm27/ece.energy.2018.4_e_UNFC_China_Petroleum_BD_FINAL_as_submitted.pdf)

<sup>73</sup> [https://www.unece.org/fileadmin/DAM/energy/se/pdfs/Comm27/ece.energy.2018.5\\_e\\_UNFC\\_China\\_Minerals\\_BD\\_FINAL\\_as\\_submitted.pdf](https://www.unece.org/fileadmin/DAM/energy/se/pdfs/Comm27/ece.energy.2018.5_e_UNFC_China_Minerals_BD_FINAL_as_submitted.pdf)

<sup>74</sup> 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>

<sup>75</sup> 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>

<sup>76</sup> 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>

The Americas, blessed with abundant natural resources, has issues of indigenous populations or the First Nations at play.<sup>77</sup> Rich culture, often captured in the timelessness of monuments and archaeological sites, is an area of intersection with resource development. Mexico has piloted UNFC for identifying and classifying the social and environmental aspects to project advancement in a number of their development areas.<sup>78</sup>

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 and in particular within the context of UN instruments.

#### 4.7 INTERNATIONAL CENTRES OF EXCELLENCE ON SUSTAINABLE RESOURCE MANAGEMENT

International Centres of Excellence on Sustainable Resource Management (ICE-SRM) will be a collaborative network of organizations focused on supporting the sustainable management of the resources needed for development in line with the 2030 Agenda and the Paris Climate Agreement<sup>79</sup>. The Centres are conceived to provide – in full compliance with the adopted UNECE standards and guidelines – policy support, technical advice and consultation, education, training, dissemination, and other critical activities for stakeholders involved in the sustainable development of national resource endowments. ICE-SRMs will promote within its activity footprint the global deployment of UNFC and UNRMS to describe the resources needed for the attainment of the 2030 Agenda and support their management. ICE-SRMs are 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

#### 4.8 THE NEW NORMAL

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.<sup>80</sup> 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 is 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. 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. UNECE stands ready to support the sustainable management of resources.

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<sup>77</sup> 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>

<sup>78</sup>[https://www.unece.org/fileadmin/DAM/energy/se/pdfs/egrm/egrm10\\_apr2019/ECE.ENERGY.GE.3.2019.5\\_e.pdf](https://www.unece.org/fileadmin/DAM/energy/se/pdfs/egrm/egrm10_apr2019/ECE.ENERGY.GE.3.2019.5_e.pdf)

<sup>79</sup> See [https://www.unece.org/fileadmin/DAM/energy/se/pdfs/UNFC/ICE-SRM/20200925\\_EGRM-11-2020-INF3\\_ICE.SRM\\_Criteria\\_\\_\\_ToR\\_Final.pdf](https://www.unece.org/fileadmin/DAM/energy/se/pdfs/UNFC/ICE-SRM/20200925_EGRM-11-2020-INF3_ICE.SRM_Criteria___ToR_Final.pdf)

<sup>80</sup> 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.

# United Nations Resource Management System

An overview of concepts, objectives and requirements

The multifaceted requirements of sustainable development are primarily dependent on the optimal and responsible use of natural resources. A new paradigm of optimising resource efficiency and progressing towards a circular economy is required to realise the need for balanced development of natural resources. The United Nations Resource Management System (UNRMS) is being designed as a unifying framework for the integrated management of resources.

UNRMS is based on the globally accepted United Nations Framework Classification for Resources (UNFC), which has incorporated a unique methodology of assessing resources through the triple lenses of environmental-social-economic viability, technical feasibility and confidence in estimates. UNRMS will be a voluntary global standard for sustainable integrated resource management, within the framework of public, public-private and civil society partnerships, that is uniformly applicable to all resources.

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