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C O M M I S S I O N

Governance of High Seas Ecosystems:
Big Data & AI

Interim Report | 21st December 2021

Produced by:

NLA INTERNATIONAL
BLUE ECONOMY SOLUTIONS

Government Offices of Sweden
Ministry of the Environment   IUCN

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**Presentation
of
Interim Report**

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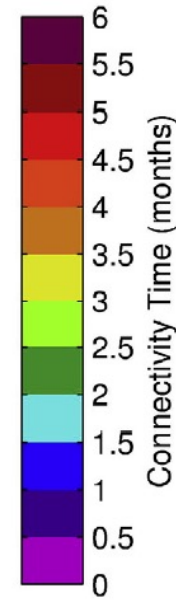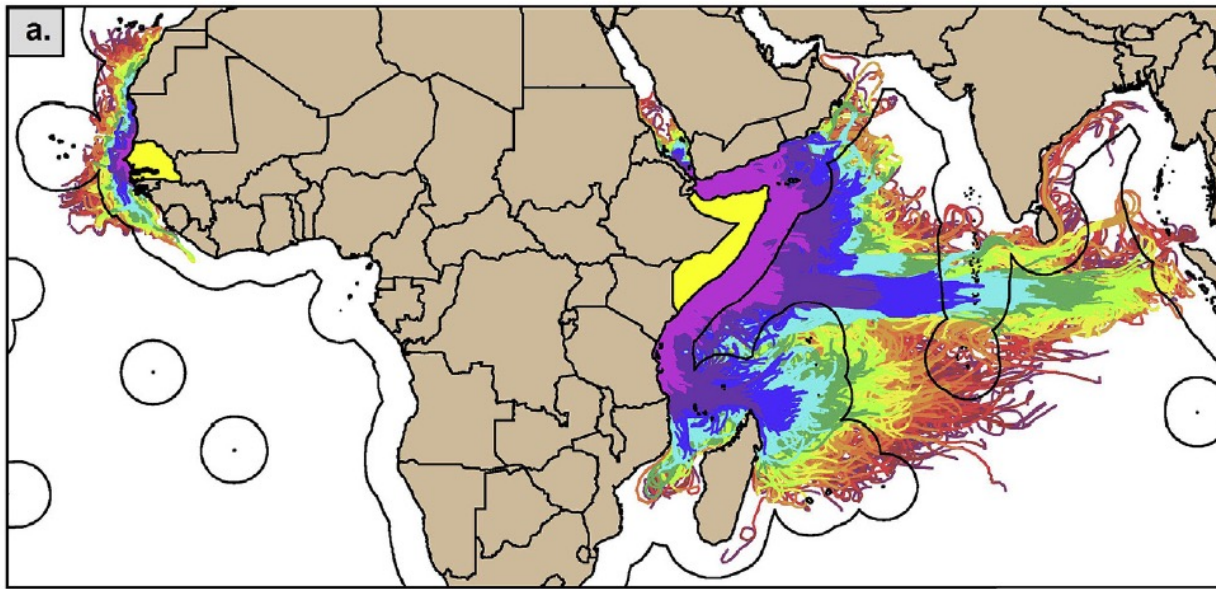&
Kevin Fleming*

Report: purpose

- What problems can Big Data and AI technologies address in High Seas Governance?
- What are the opportunities, challenges, enablers, and starting points?
- Does this extend to ocean governance and management more broadly?
- Our approach:
  - Review the state-of-the-art in enabling earth- and space-based remote sensing technologies.
  - Define the potential role of Big Data systems in ocean governance, and their current limitations.
  - Analyse how Artificial Intelligence of varying sophistication and integration can help, and how it can be trusted.
  - Contextualise findings in terms of stakeholder needs, priorities, and societal values.
- We did not:
  - Seek to formulate policy.
  - Architect technically deep solutions.
  - Perform first-stage feasibility tests or experiments.

Report: notes on methodology

- A mixed methods approach was taken considering stakeholder views and technical domain expertise:
  - Limited stakeholder survey of domain experts and end-users:
    - Understand needs and priorities for improved governance in ABNJs.
    - Explore the state-of-the-art from an end-user perspective.
    - Identify key solution goals.
  - Targeted interviews of domain experts:
    - Rich qualitative examples of 'good' and 'bad' ocean governance. What does good look like for high-seas governance?
    - What is the leading edge of technological solutions today?
  - Research phase including maritime domain, blue economy, ecosystem experts, and emerging technologies experts.
  - Internal peer review by the SSC's expert group.
    - The report will be published as a white paper and will inform future academic work.

The need for improved high-seas governance

- Proliferation of industrial use of the high-seas:
  - Tragedy of the commons.
  - Accelerating, highly unequal, use.
  - New threats from seafloor mineral extraction and harvest of marine genetic resources.
- Problems outside EEZs migrate in:
  - Damage caused to high-seas ecosystems affects vast, sometimes distant, coastal areas.
  - Impacts of coastal economies and ways of life, particularly for SIDS.

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Analysis of the flow of surface water from ABNJs to the coastal zone of the Federal Republic of Somalia and the Republic of Senegal. Currents carry what occurs in ABNJs to coastal zones.
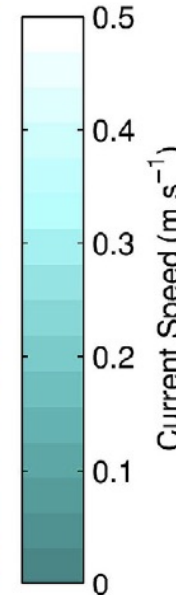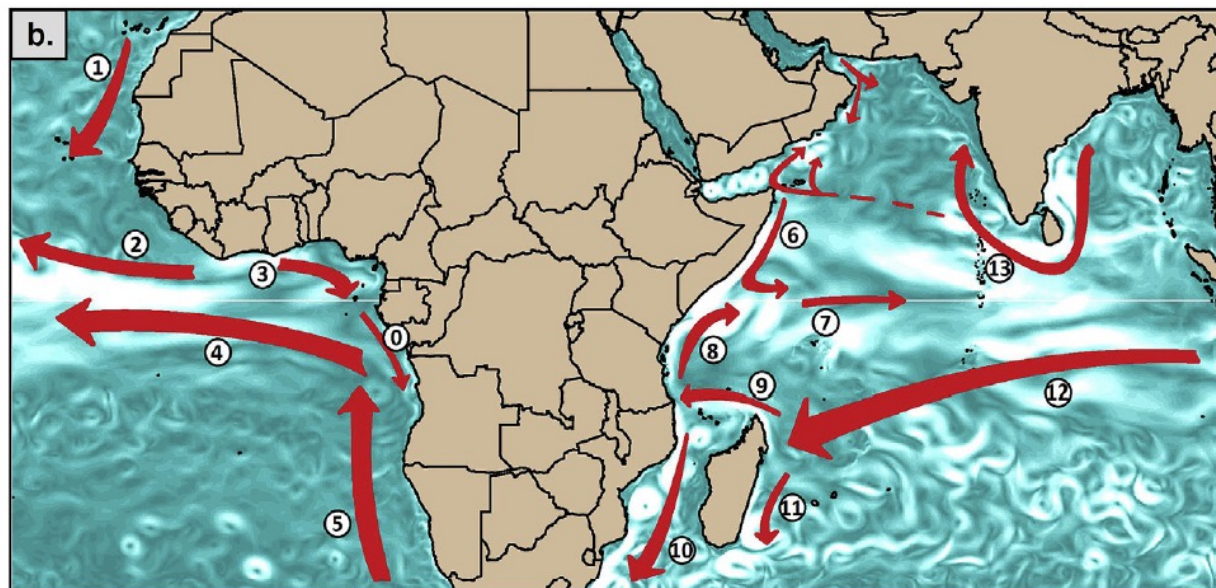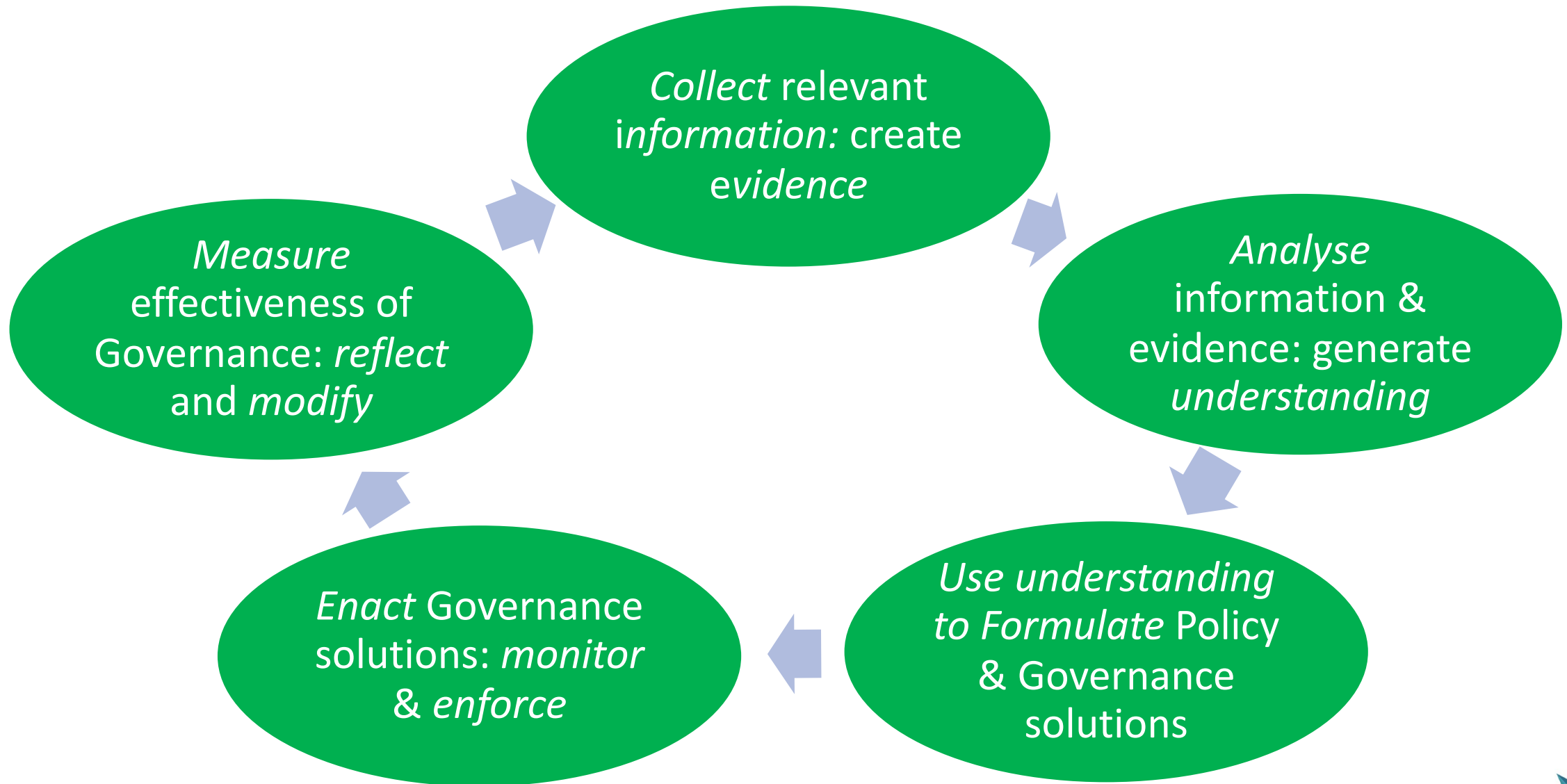
Popova, Ekaterina, et al. "Ecological connectivity between the areas beyond national jurisdiction and coastal waters: Safeguarding interests of coastal communities in developing countries." *Marine Policy* 104 (2019): 90-102.

The need for improved high-seas governance

- The issue of an 'unfinished agenda':
  - Existing UNCLOS provisions for the regulation of the high-seas were conceived before the extent of ocean biodiversity and resources were known. High seas governance is an 'unfinished agenda' in need of urgent attention.

- Paradigm shift in the art of the possible:
  - Modern Big Data & AI methods are potentially transformative capabilities, and key examples (e.g., reduction of illegal fishing around the Ascension Islands) begin to show what can be achieved.

- Complexity necessitates sophistication & persistence.

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Generic Governance Cycle: use of information, evidence & analysis

Collect relevant *information:* create e*vidence*

Analyse information & evidence: generate *understanding*

Use understanding *to Formulate* Policy & Governance solutions

Enact Governance solutions: *monitor* & *enforce*

Measure effectiveness of Governance: *reflect* and *modify*

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Technology-enabled cycle to create and sustain good Ocean Governance

Technology to **collect data**: earth- & space-based remote sensing

Technology to **analyse the data**: traditional AI/ML & generative Deep Learning AI

Technology to measure **effectiveness** of OG policies: AI to **measure impact** post OG policy changes

Technology to support OG delivery: **providing evidence to underpin policy** formulation

Technology to inform **enforcement** action: **situational awareness** in areas of jurisdiction

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Art of the possible – Sensing

- Space-based:
  - Far more numerous & more affordable.
  - Increased Coverage: both geographically & in frequency.
  - Greatly reduced latency – e.g., trailing pairs.

- Sea based:
  - Above-water: remotely operated, cooperative, extreme endurance.
  - On-water: akin to AIS, every vessel above X-tonnes to collect certain data.
  - Under-water/seabed: remotely operated, cooperative, extreme endurance.

- Historical: already "sensed"
  - Archived data is a potentially huge but untapped resource.

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Art of the possible – Big Data

- Maximise knowledge derived from existing resources whilst minimising costs:
  - Data sharing and re-use; making it easy to share, to find, and to use.
  - Evidence-led data gathering strategies:
    - What to gather?
    - How much is enough?
    - Which assets to deploy?
  - Maximise knowledge and evidence retrieval from existing data.
- Need for varied extensive 4-D data:
  - Multi-modal.
  - Environmental / ecological / anthropological.
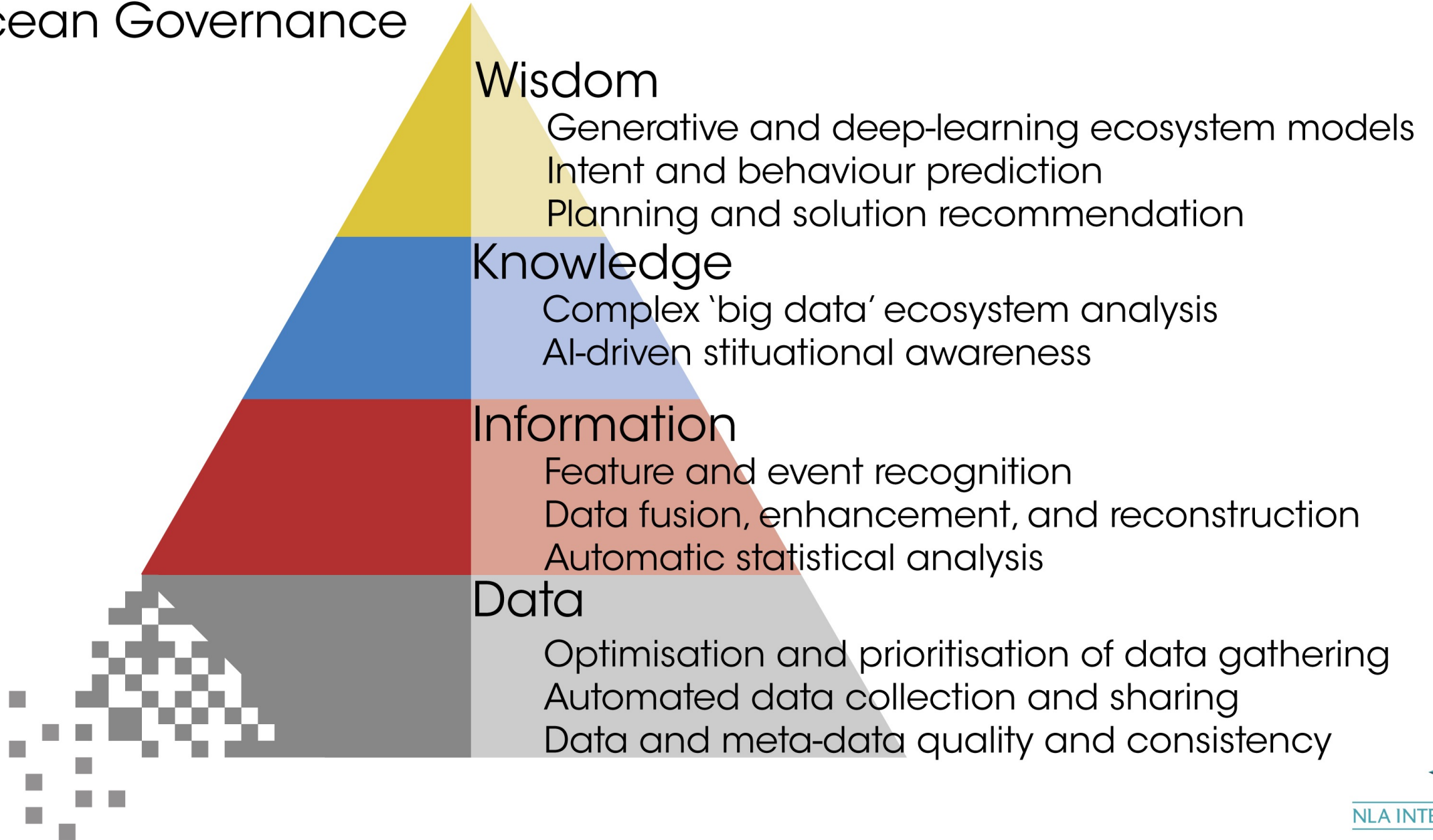- Trust and non-rivalry.

amazon · UBER · Microsoft · Google · f · TESLA
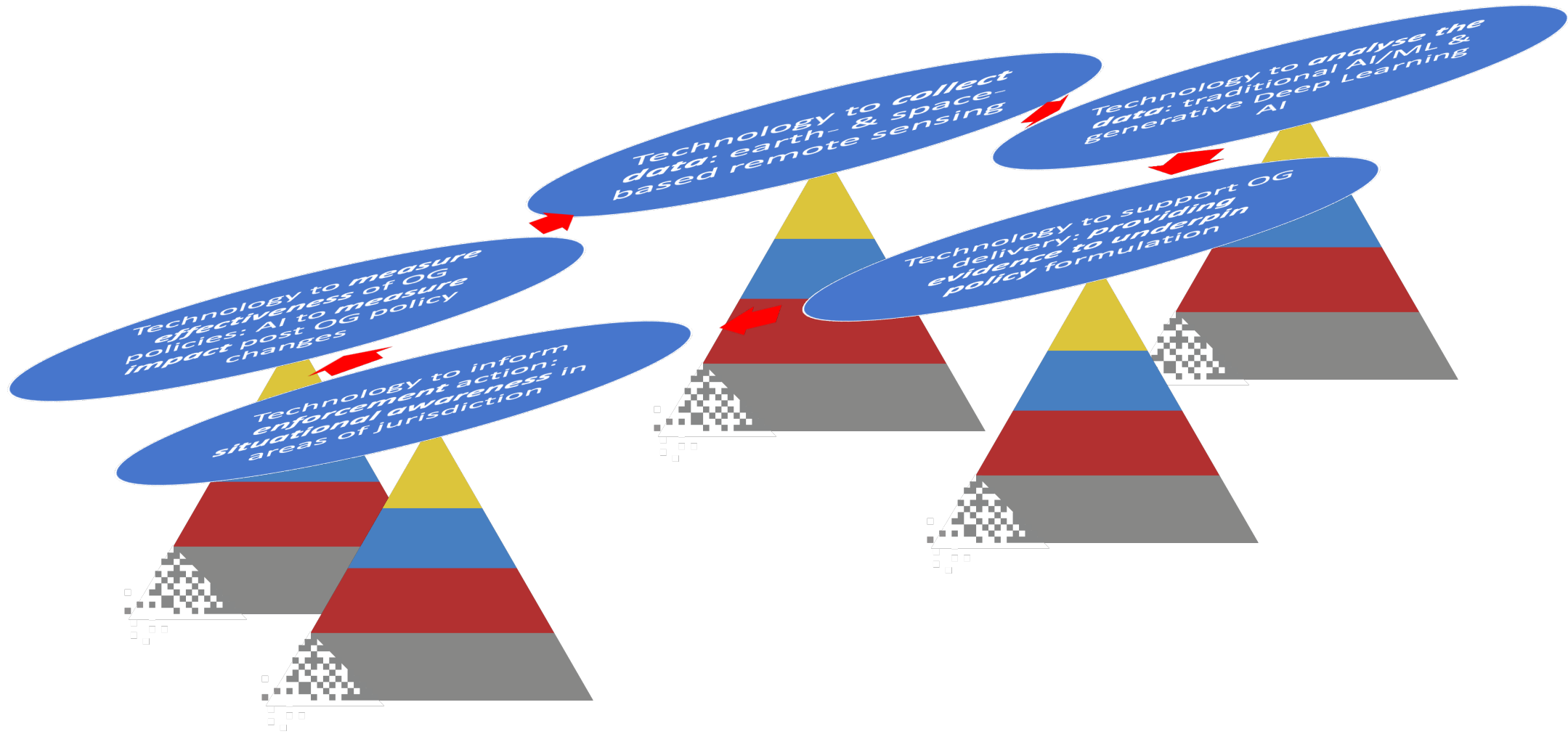
David Parkins

Art of the possible – AI

- Codify expert processes:
  - Cost-effective, scalable, and continuous ocean analysis and management, underpinned by traditional AI processes.
- See more from less:
  - Generate more understanding and evidence from data and information, making the most of potentially fragmented, multi-modal, data and sources.
- Capture complexity, understand causality, and quantify certainty:
  - Advanced methods to analyse complex systems and minimise human bias.
- Transparency and trust – black boxes becoming clear, but verification and validation needs domain specific thought.
- Translate and tailor:
  - Traditional AI solutions are candidates for technology translation from other domains.
  - Cutting-edge methods will require bespoke solutions, built for ocean ecosystem analysis.
- AI is a path to equitable technology; democratising expertise and making ocean management accessible.

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AI for Ecosystems & Ocean Governance

Wisdom
- Generative and deep-learning ecosystem models
- Intent and behaviour prediction
- Planning and solution recommendation

Knowledge
- Complex 'big data' ecosystem analysis
- AI-driven stituational awareness

Information
- Feature and event recognition
- Data fusion, enhancement, and reconstruction
- Automatic statistical analysis

Data
- Optimisation and prioritisation of data gathering
- Automated data collection and sharing
- Data and meta-data quality and consistency

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AI-enabled Wisdom *underpins* the Ocean Governance Cycle

Technology to *collect data*: earth- & space-based remote sensing

Technology to *analyse the data*: traditional AI/ML & generative Deep Learning AI

Technology to measure *effectiveness of OG policies*: AI to measure impact post OG policy changes

Technology to support OG delivery: providing evidence to underpin policy formulation

Technology to inform enforcement action: situational awareness in areas of jurisdiction

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A Vision of Future Ocean Governance?

- FAIR standardised data that is easy to share, find, retrieve, and use for machines, experts, and non-expert end-users alike.

- Open-source data for the high seas: a global commons of knowledge.

- Virtuous cycle including industry, gathering and sharing ecosystem understanding for social good and appropriate incentives.

- Ocean ecosystem assessment that is radically less expensive and more accessible, based on Big Data & AI derived evidence.

- Democratisation of expertise through AI methods.

- Continuous ecosystem monitoring, informing dynamic policy and rapid enforcement.

- A deep, consistent, understanding of ocean ecosystems in their complex totality.

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Path to technologization

- Data standardisation and platform-based sharing.
- Feasibility studies and AI technology translation:
  - Data normalisation, sharing, and retrieval.
  - AI-assisted ecosystem analysis and assessment (understanding).
  - AI for Maritime Situational Awareness (monitoring).
  - AI for ocean management and resource deployment (response).
- AI solution development:
  - Mature implementations tailored to the ocean domain.
  - Generative and Deep Learning AI to capture and interpret complexity, and form hypotheses regarding ecosystem behaviour and trends.
- Underpinning in strategic sensor deployment and optimisation to improve 4-D image of the oceans.

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What Next?

- Much (or even all) of this can be done now, or very soon …
- But it needs to be appropriately resourced …

- Who will do it?
- Who will be the global leaders in this vitally important endeavour?
- Is it you / us?

- How does this impact on UNCLOS … and on ABNJ?
- The SSC is leading by piloting this approach …

- *So, let's get started!!*