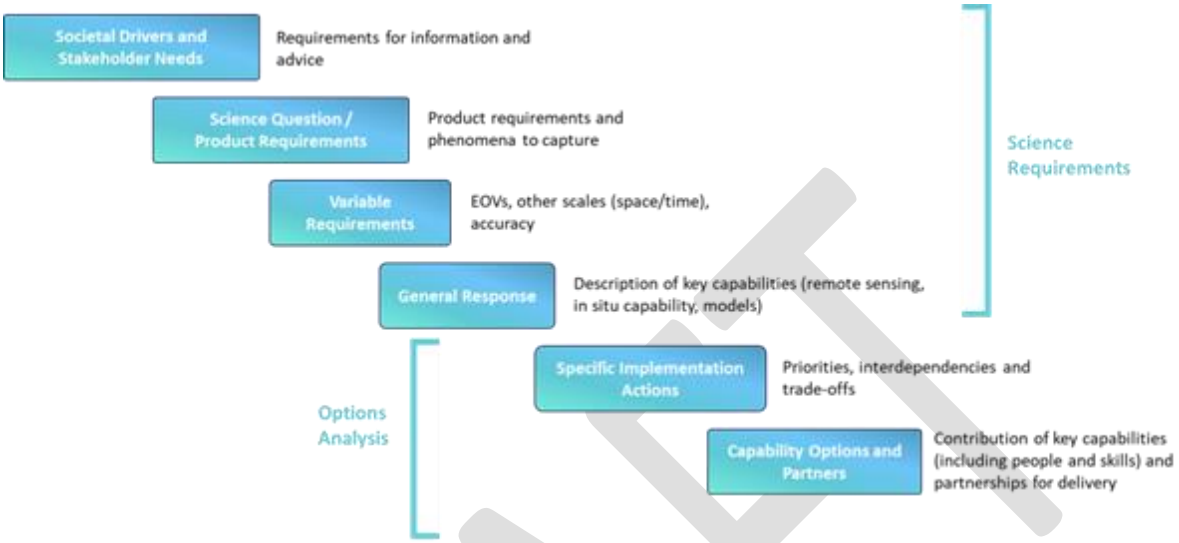
4. The Science Requirements Framework: Approach to Identifying Requirements.

The Future Marine Research Infrastructure (FMRI) programme sets the challenge of maintaining or enhancing the UK's scientific capability while achieving both environmentally and economically sustainable operations. This challenge also presents the opportunity to consider holistically the UK's future marine science ambitions and how we can maximise science impact, and information value to society for investment by a) combining a range of observations and digital tools in new and smart ways, and b) advancing partnerships nationally and internationally to deliver a more integrated collaborative capability to deliver to science and society.

In practical terms, the SRF will set out, in a step-by-step way, how overarching science goals relate to capability needs, drawing on national strategies and studies to date, and international best practice projecting forward on the timeline to 2040. It will outline the overarching science questions/knowledge gaps and information requirements, consider the underlying phenomena to capture and how this then influences variables/space/time scales, recognising the need for both sustained observations and experimental capabilities, ensuring experimental flexibility to continue to advance innovative science and observe the ocean smarter, and deliver more value for investment. The SRF will then consider in general terms the key capability needs, in order to provide an evidence-based prioritisation of requirements ensure the best possible outcome for investment into Marine Science.

The SRF will be used to inform considerations of combined capability options (starting with the business case for investment when the RRS James Cook comes to the end of its life) and guide national and international partnerships development. To maximise information value for investment, the need to consider individual capabilities as an integrated system to optimise observation synergies, interdependencies, hence providing a framework to consider options, priorities and manage trade-offs. As outlined in the figure XX, there will need to be a brokering between the requirements and options decision-making, design and implementation as an iterative process; as such, the SRF is expected to be a living document that will develop throughout the FMRI planning and development process.

Figure XX: Approach to articulating requirements and relationship with options discussions. Adapted from Smith, N., et al., 2019 The Tropical Pacific Observing System, Frontiers in Marine Science Volume 6 - 2019 | https://doi.org/10.3389/fmars.2019.00031



The SRF will draw on the work of the NZOC Work Package 1: Future Science Requirements. The work package very much focused on disciplinary science and the practicalities of delivering science now and into the future. Hence, the SRF is organised under overarching Marine Science Grand Challenges to organise and elevate ambition in Marine Science to address society's challenges.

The SRF highlights the key knowledge gaps and uncertainties within these grand challenges to articulate observation requirements that will stretch our capability and drive innovation in how we bring observations and digital tools together. Examples are identified to challenge future marine research infrastructure in different ways – whether that be resolution, remoteness, new variables, integration across scales, variables, etc.

At this stage, it helps to articulate some key principles for a future marine research infrastructure:

Principles (Draft)

- **Accessible and Impactful –** marine research infrastructure must realise the full societal value and impact of marine data and the science it enables, by creating much wider access to the infrastructure and data, and by increasing the range and accessibility of information and knowledge that comes from it.
- **Flexible and Responsive –** marine research infrastructure must provide for societal risks and challenges that are prioritised now, and those that will emerge in the future, ensuring

that investment continues to maximise opportunities for innovative science and the knowledge it generates.

- **Integrated and seamless –** through digital and physical integration the research infrastructure must provide added value from the diversity of technologies that are needed meet the challenges of the complexity, hostile nature and sheer scale of the marine environment.
- **Innovative and adaptable –** marine research infrastructure must facilitate technological innovation and be adaptable to evolve, using new technologies to provide the data and information required into the future.
- **Resilient and collaborative –** marine research infrastructure must have built-in system resilience such that dependencies are robust and prevent single points of failure, that transitions to new technology are smooth and without breakpoints, and that it fully integrates with and adds value to global observing systems and partnerships.