Ocean Discovery League, Saunderstown, USA. • 2022 Global Deep-Sea Capacity Assessment

Results: SIDS & Non-SIDS Income Groups

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1 Overview

Small Island Developing States (SIDS) are a distinct group of countries and territories located in the Caribbean, the Pacific, the Atlantic, and Indian Ocean (Figure 1). Due to factors like small population size, remoteness, high transportation costs, and fragile land and marine ecosystems, they face unique social, economic, and environmental challenges. For many SIDS, the Exclusive Economic Zone (EEZ) is considerably larger than the country's land mass, so the ocean is their primary source of natural resources. These factors make SIDS particularly vulnerable to biodiversity loss and climate change [1]. As such, they are a unique consideration for deep-sea research and exploration capacity. Here, we present the results of analysis of SIDS and non-Small Island Developing States (non-SIDS) categorized by World Bank Income Group [2].

1.1 SIDS & Non-SIDS Income Groups

For SIDS, we evaluated 58 geographical areas (GeoAreas) by economic groups, including 23 high-income (40%), 16 upper-middle-income (28%), 12 lower-middle-income (21%), one low-income (2%), and six SIDS that are not categorized (10%) (Figure 1; SIDS Income Groups) [2]. Of the 58 SIDS, 41 were sovereign countries (71%), and 17 were dependent territories (29%) (Figure 3A; SIDS GeoAreas) [3]. Nearly half of all SIDS are located in Latin America & the Caribbean (28 SIDS); one-third are in Oceania (19 SIDS). Bermuda is the only SIDS in Northern America; Europe has no SIDS (SIDS GeoAreas) [3].

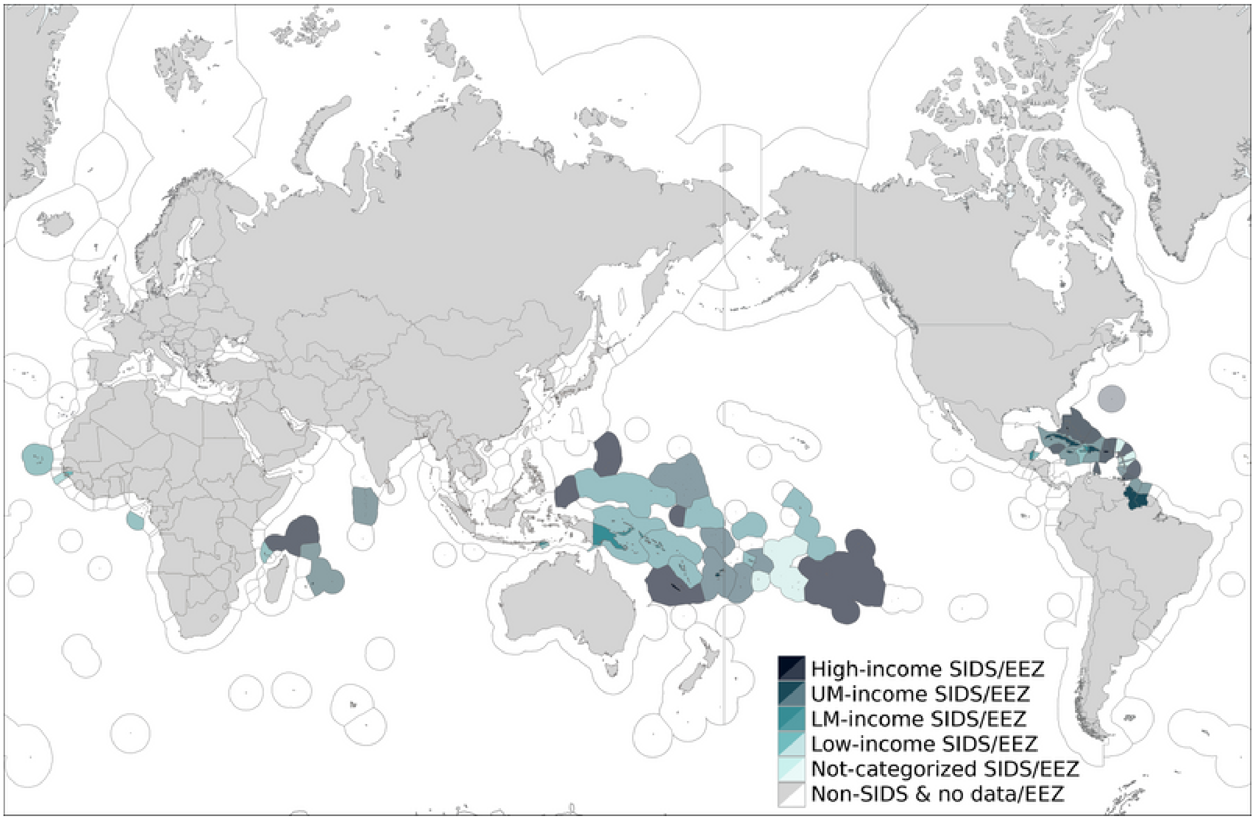


Figure 1
Small Island Developing States
Map of SIDS for which we have survey and/or research data, colored by income group: high income, upper-middle income, lower-middle income, low income, and not categorized. Light shades of each color indicate the EEZs of each GeoArea. [2][3][4][5][6]

For non-SIDS, we evaluated 200 GeoAreas by economic groups, including 54 high (27%), 38 upper-middle (19%), 42 lower-middle (21%), 25 low-income (13%), and 41 not-categorized (21%) GeoAreas (Figure 2; Non-SIDS Income Groups) [2]. Of the 200 non-SIDS, 155 were sovereign countries (78%), and 45 were dependent territories (23%) (Figure 3A; Non-SIDS GeoAreas) [3]. Thirty-one percent of all non-SIDS GeoAreas are located in Africa (62 GeoAreas), 24% are in Europe (49 GeoAreas), and 22% are in Asia (44 GeoAreas) (Figure 2; Non-SIDS GeoAreas).

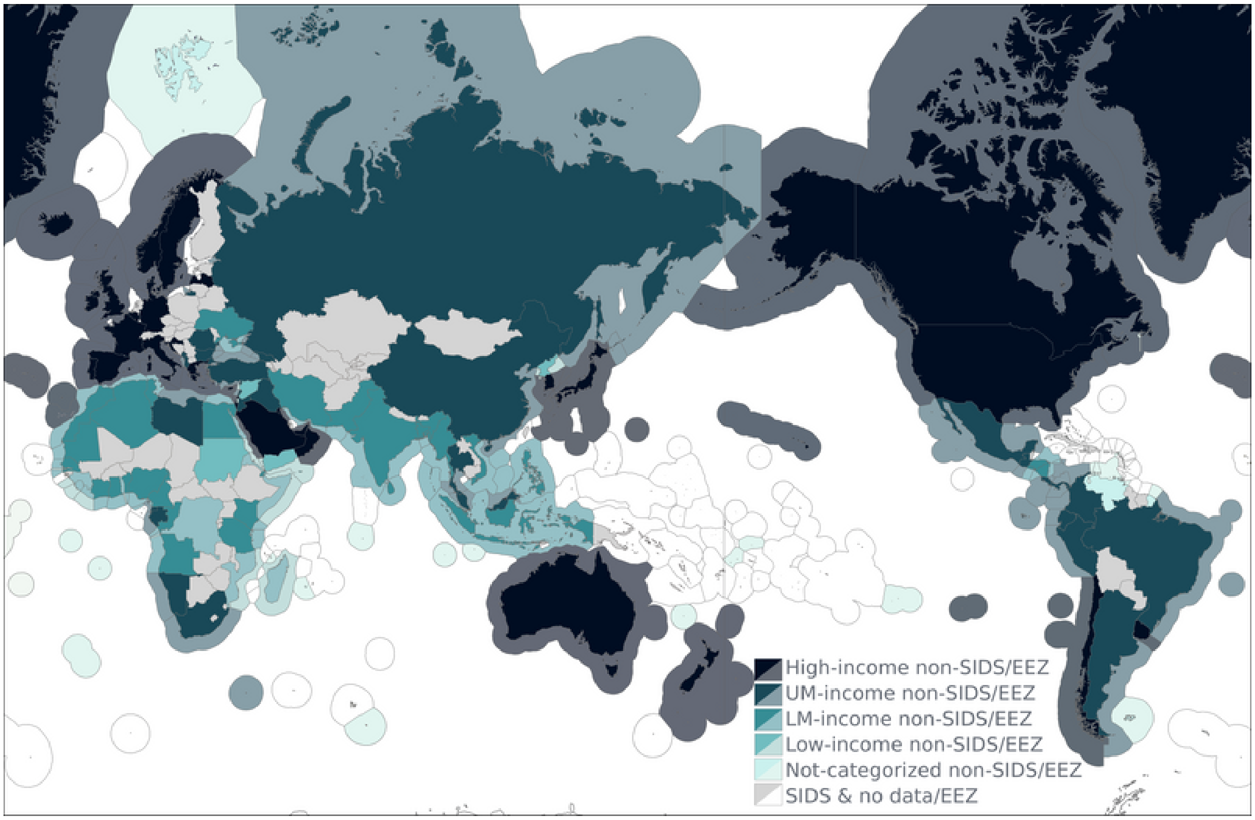


Figure 2
Non-Small Island Developing States
Map of non-SIDS for which we have survey and/or research data, colored by income group: high income, upper-middle income, lower-middle income, low income, and not categorized. Light shades of each color indicate the EEZs of each GeoArea. [2][3][4][5][6]

1.3 SIDS & Non-SIDS Data

This part of the assessment includes information about the technical and human capacities of 57 SIDS and 129 coastal non-SIDS worldwide.

For 32 SIDS, we have both survey and research data; for 24 SIDS, we have only research data; and for one SIDS, Singapore, we have only survey data (Figure 3B; SIDS Data Sources). We did not collect research data for two SIDS, Singapore and Bahrain, because less than 1% of their EEZs are deeper than 200 m. Guinea-Bissau is the only low-income SIDS.

For 86 non-SIDS, we have both survey and research data, and for 124 non-SIDS, we have research data only. We have only survey data for four high and one upper-middle-income non-SIDS (Figure 3B; Non-SIDS Data Sources), such as Belgium and Germany, because they have less than 1% of their EEZs deeper than 200 m.

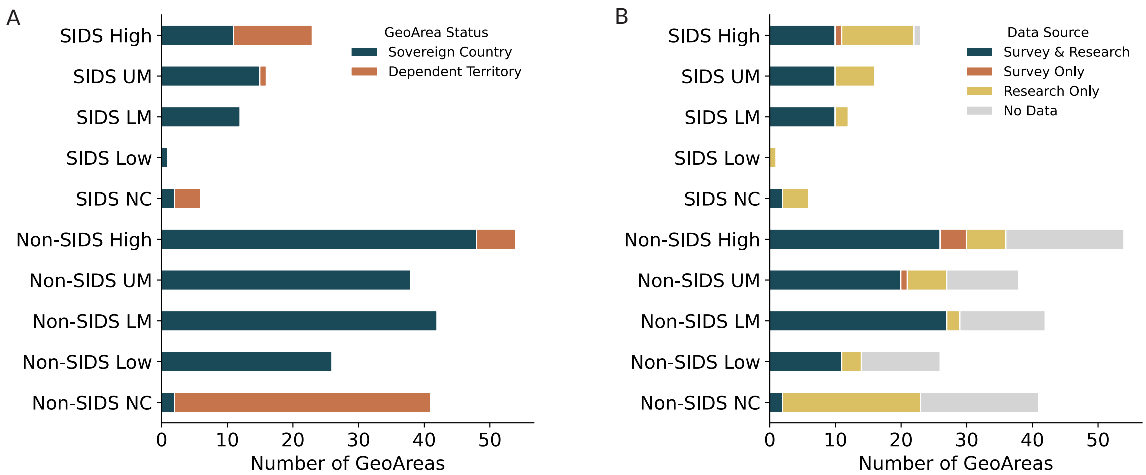


Figure 3
GeoArea Information
(A) Number of sovereign countries (blue) and dependent territories (orange) in each income group. **(B)** Number of GeoAreas with survey and research data (blue), survey data only (orange), research data only (yellow), and no data (grey) used in this assessment for each income group. [2][3]

1.4 SIDS & Non-SIDS Exclusive Economic Zones

All 58 SIDS claim marine EEZs, covering a combined 34,870,385 km^2, or ~25% of all EEZ area worldwide (Figure 4A, B; SIDS EEZs) [4][5][6]. Fifty-six SIDS have deep ocean in their EEZs (>200 meters below sea level; mbsl), encompassing an area of approximately 33,993,011 km^2, or 97% of the total EEZ area within the jurisdiction of SIDS.

Of the 200 non-SIDS, 43 have no ocean, and 157 claim marine EEZs, covering 103,358,385 km^2 (Figure 4A, B; Non-SIDS EEZs) [4][5][6]. Of those 157 with marine EEZs, 141 GeoAreas have >1% deep ocean in their EEZs by area, encompassing an area of approximately 79,273,161 km^2, or 77% of the total EEZ area across non-SIDS GeoAreas.

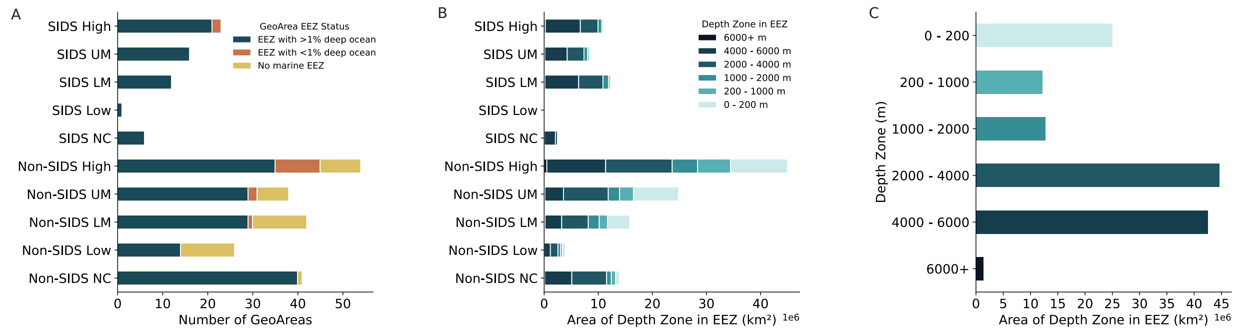


Figure 4
Exclusive Economic Zones
(A) Number of GeoAreas with >1% deep ocean within their EEZ (blue), <1% deep ocean within their EEZ (orange), and no EEZ (yellow). **(B)** Area of each depth zone for all EEZs claimed in each income group. **(C)** Total area of EEZs by oceanographic depth zone. [4][5][6]

Of the SIDS, lower-middle-income GeoAreas claim the largest total EEZ area, with approximately 36% of the entire EEZ area covered by SIDS (Figure 4B). Not-categorized SIDS have the largest proportion of their own EEZ area (99%) at a depth of 200 m and below, while low-income SIDS have the smallest proportion (54%). The largest depth zone by area in SIDS EEZs lies at 4,000-6,000 mbsl, covering 54% of all SIDS EEZs, followed by 2,000-4,000 mbsl (32% of all SIDS EEZs). All income groups, except low-income SIDS, have their largest depth zone by area at 4,000-6,000 mbsl (up to 81% of EEZ area for not-categorized SIDS and between 48 and 58% for the others). The largest deep-sea zone for low-income SIDS is 2,000-4,000 mbsl (20%). The second largest depth zone by area for all SIDS combined is 2,000-4,000 m (32% of all SIDS EEZs). The depth zone beyond 6,000 mbsl is the smallest (1%).

Of the non-SIDS, high-income GeoAreas claim the largest EEZ area, about 44% of the total EEZ area covered by non-SIDS claims; 77% is at a depth of 200 m and deeper (Figure 4B). However, not-categorized non-SIDS have the largest proportion of their own EEZ area (95%) at a depth of 200 m and deeper, while upper-middle-income non-SIDS have the smallest proportion (66%). Low-income non-SIDS claim the smallest EEZ area and the smallest deep-sea area within their EEZs. The largest depth zone by area in non-SIDS lies 2,000-4,000 mbsl, covering 32% of all EEZs, followed by 4,000-6,000 mbsl and 0-200 mbsl (23% each). All income groups, except the upper-middle-income non-SIDS, have their largest depth zone by area at 2000-4000 mbsl (between 27 and 46%). The largest deep-sea zone for upper-middle-income non-SIDS GeoAreas is 0-200 mbsl (34%).

> "It helps to highlight capacity gaps and focus capacity-building efforts so that countries are in a better position to decide independently whether and how to proceed with ocean resource development activities."
>
> — Dr. Jacqueline Evans, 2019 Goldman Prize Recipient, Cook Islands

2. Survey Responses & Demographics

2.1 Geographic & Demographic Representation

Respondents were asked four questions about their geographic and demographic representation: which GeoArea they represent, in what GeoArea they live, their gender identification, and their age group.

Which GeoArea would you like to represent for this survey? (Q1)

We received 73 complete surveys representing 33 SIDS for the Global Deep-Sea Capacity Assessment Survey (Table 1). Twenty-five responses were for 11 high-income SIDS, 22 for ten upper-middle-income SIDS, 20 for ten lower-middle-income SIDS, and six for two not-categorized SIDS. We received no survey responses for low-income SIDS. Of the SIDS, we received the most survey responses for Trinidad & Tobago (7), Vanuatu (5), and Barbados (5).

We received 286 complete surveys representing 90 non-SIDS (Table 1). One hundred ten respondents represented 29 high-income, 53 represented 21 upper-middle-income, 87 represented 27 lower-middle-income, 24 represented 11 low-income, and 12 represented two not-categorized non-SIDS.

Table 1

Income Group	Number of GeoAreas with Survey Responses	Number of Survey Responses
SIDS: High	11	25
SIDS: Upper-middle	10	22
SIDS: Lower-middle	10	20

SIDS: Low	0	0
SIDS: Not-categorized	2	6
Non-SIDS: High	30	110
Non-SIDS: Upper-middle	21	53
Non-SIDS: Lower-middle	27	87
Non-SIDS: Low	11	24
Non-SIDS: Not-categorized	2	12

As what gender do you identify? ([Q41](#))

Forty-one of the respondents for SIDS were male (56%), 30 were female (41%), one was gender fluid (1%), and one was agender (1%) ([Figure 5](#)A).

One hundred eighty-seven of the respondents for non-SIDS were male (65%), 93 were female (32%), one was gender fluid (<1%), and six (2%) preferred not to answer.

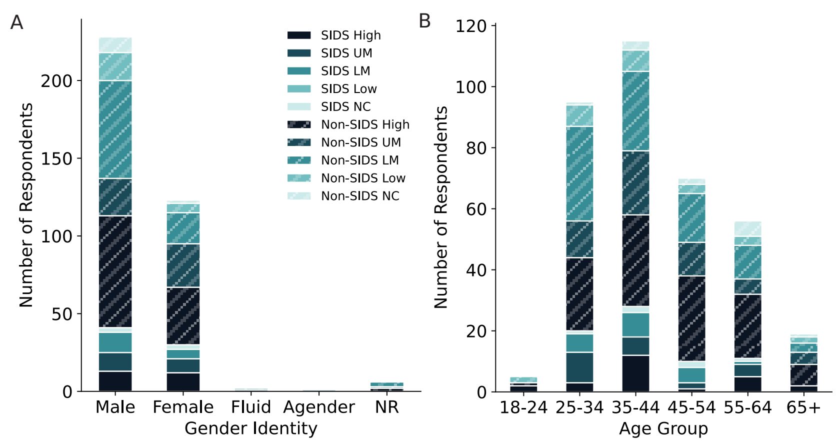


Figure 5
Respondent Demographic Representation
(A) Gender identity of survey respondents for each income group. **(B)** Number of survey respondents by age group for each income group.

What is your age? ([Q39](#))

Overall, SIDS had the most representation from the 35-44 year age group (33-48%) in all income groups, except in upper-middle-income SIDS, where the younger 25-34 year age group was dominant (45%). High-income SIDS were the only ones with responses from the 65+ and 18-24 year age groups (8% of responses within each group) ([Figure 5](#)B).

Non-SIDS had the most representation from respondents in the 35-44 year age group (30%), followed by the 25-34, 45-52, and 55-65 yr age groups (26%, 21%, 16%). The fewest responses were from the 18-24 yr and 65+ yr age groups (1%, 6%), and high and low-income non-SIDS were the only income groups with responses from the 18-24 yr age group.

2.2 Professional Representation

Respondents were asked four questions about their professional representation: what is their highest level of education completed, in what organizational sector do they work, what are their primary roles, and in what marine environments do they work.

What is the highest degree or education level you have completed? (Q42)
Most respondents for both SIDS and non-SIDS held advanced degrees (Figure 6A). Among respondents for SIDS, 26 had a doctorate (36%), and twenty-one had a master's degree (29%). Sixteen held a bachelor's degree (22%). Ten had completed some graduate school, high school, or other education (14%).

Among respondents for non-SIDS, 158 had a doctorate (55%), with the highest density in high-income non-SIDS. Seventy-nine had a master's degree (28%), and twenty-nine held a bachelor's degree (10%). Twenty-one had completed some graduate school, high school, or other education (7%).

What is the organizational sector of your affiliation? (Q43)
Most respondents for SIDS worked in government (44%) or academia (25%). Smaller percentages of respondents worked for not-for-profit organizations (12%), non-governmental organizations (11%), or other sectors (8%) (Figure 6B). The largest proportion of respondents for high-income SIDS were affiliated with academia. In lower- and upper-middle-income SIDS, most respondents had a governmental affiliation. Most respondents for not-categorized SIDS worked for not-for-profit organizations. We also note that none or very few respondents worked in academia in not-categorized and lower-middle-income SIDS.

Most respondents for non-SIDS worked in academia (47%) or government (30%). Smaller percentages of respondents worked for not-for-profit organizations (7%), non-governmental organizations (5%), or other sectors (11%).

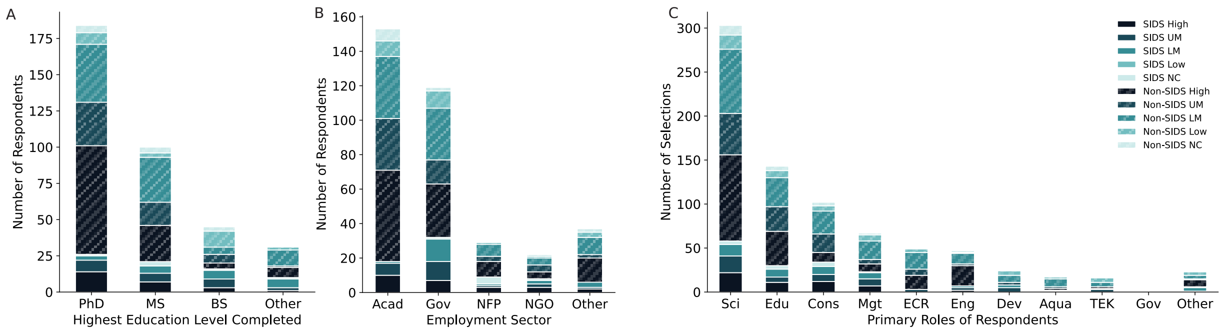


Figure 6
Respondent Professional Representation
(A) Completed education level of respondents for each income group. **(B)** Organizational sector of respondents for each income group: academia (Acad), government (Gov), not-for-profit (NFP), non-governmental organization (NGO), or other. **(C)** Number of respondents who identified with up to three roles that they represent in their communities: science/research (Sci), education/outreach (Edu), conservation/advocacy (Cons), management/policy/law (Mgt), student/early career researcher (ECR), engineering/technology (Eng), developing nation/community (Dev), aquatics/recreation (Aqua), traditional ecological knowledge (TEK), Government (Gov), or other.

What are the primary roles you represent in your GeoArea? (Q5)

Respondents were asked to select up to three primary roles they represented in their communities from a list of the following options: science/research, education/outreach, policy/law/management/government, developing nation/community, engineering/technology, traditional knowledge, aquatics/recreation, industry/investment, philanthropy, student/early career, conservation/advocacy they were also allowed to enter free-text if a role of theirs was not an option.

Fifty-eight respondents for SIDS considered themselves scientists or researchers (79%), 34 worked in conservation (47%), and 30 worked in education and outreach (41%). Roles in government and aquatics were the least represented. Three were students or early career researchers (4%), all of whom represented upper-middle-income SIDS. The least representation was in traditional knowledge holders, government, and aquatics (Figure 6C).

Two hundred forty-five respondents for non-SIDS considered themselves scientists or researchers (85%), 113 worked in education and outreach (39%), and 68 in conservation (24%). Forty-seven were students or early career researchers (16%). Fewer respondents represented engineering/technology, developing nations/communities, aquatics or recreation, traditional ecological knowledge, and other roles.

If you carry out field research, in what marine environment(s) do you work? (Q6)

Respondents were asked to select all marine environments in which they do field work from a list of the *following options: inshore, nearshore, continental shelf, deepwater, or none of the above; they were also allowed to enter free-text if a marine environment in which they work was not an option.*

The largest fraction of respondents for SIDS worked in the inshore and nearshore environments (42%, 56%) (Figure 7). Only 25% of the respondents for SIDS worked in the deep sea. High-income SIDS had the largest fraction of respondents who worked in deep water (28%), followed by upper-middle-income SIDS (27%) and lower-middle-income SIDS (20%). Seventy-five respondents (76%) selected more than one field environment. Eighteen respondents (24%) worked in other environments or did not conduct fieldwork.

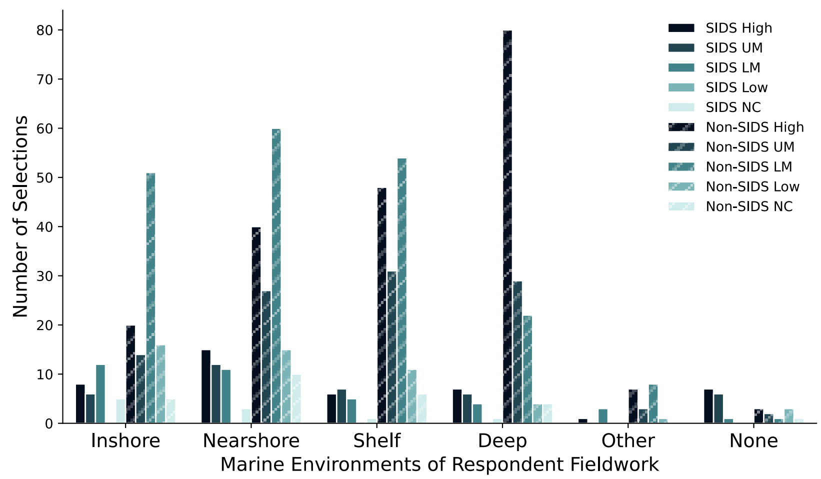


Figure 7
Respondent Field Research Environments
Number of respondents who work in each marine environment, by income group: inshore, nearshore, continental shelf (Shelf), deep ocean (Deep), other areas (Other), or none of the above (None).

The largest fraction of respondents worked in the nearshore environment and on the continental shelf (53% and 52%, respectively). Forty-eight percent of respondents for non-SIDS worked in the deep-sea environment, most of whom represented high and upper-middle-income non-SIDS. Twenty-nine respondents (10%) worked in other environments or did not conduct fieldwork.

3 Issues, Challenges, & Opportunities

3.1 Highlights

- **Issues** | Conservation & protection, fisheries & aquaculture, and climate change were the three most important deep-sea issues identified by respondents for SIDS. For non-SIDS, basic science, conservation & protection, and fisheries & aquaculture were the three most important deep-sea issues identified by respondents.
- **Challenges** | Funding, human capacity, and access to vessels were the three most important challenges identified by respondents for SIDS. Funding, access to DSVs, and access to vessels were the most important challenges identified by respondents for non-SIDS.

- **Opportunities** | Training opportunities, less expensive data collection technology, and better data access and analysis tools were identified as the three most exciting opportunities by respondents for SIDS. Training opportunities, less expensive data collection technology, and networking were identified as the most exciting opportunities by respondents across non-SIDS.

3.2 Deep-Sea Issues

What are the three most important deep-sea issues in your GeoArea? (Q3)
Respondents were asked to select up to three deep-sea issues that they considered most important for their GeoArea from a list of the following options: basic science & exploration, fisheries & aquaculture, seabed mining, conservation & protection, maritime archaeology & history, offshore oil & gas, renewable energy, safety & security, telecommunications, and climate change; they were also allowed to enter free-text if an issue was not an option.

Conservation & protection (19%), fisheries & aquaculture (19%), and climate change (15%) were the most important issues identified by respondents for SIDS (Table 2). For non-SIDS, basic science (20%), conservation & protection (18%), and fisheries & aquaculture (17%) were the most important issues identified by respondents.

Table 2

Income Group	**Most important deep-sea issues identified by respondents**
SIDS: High	Conservation & protection (19%) Offshore oil & gas (19%) Fisheries & aquaculture (18%)
SIDS: Upper-middle	Fisheries & aquaculture (20%) Conservation & protection (17%) Climate change (17%)
SIDS: Lower-middle	Climate change (25%) Conservation & protection (20%) Fisheries & aquaculture (16%)
SIDS: Low	NR
SIDS: Not-categorized	Conservation & protection (22%) Fisheries & aquaculture (22%) Basic science & education (22%) Seabed mining (22%)

Non-SIDS: High	Conservation & protection (19%) Offshore oil & gas (19%) Fisheries & aquaculture (18%)
Non-SIDS: Upper-middle	Fisheries & aquaculture (20%) Conservation & protection (17%) Climate change (17%)
Non-SIDS: Lower-middle	Climate change (25%) Conservation & protection (20%) Fisheries & aquaculture (16%)
Non-SIDS: Low	NR
Non-SIDS: Not-categorized	Conservation & protection (22%) Fisheries & aquaculture (22%) Basic science & education (22%) Seabed mining (22%)

Conservation & protection and fisheries & aquaculture were among the most important issues in every SIDS income group. Other important issues differed across groups. In high-income SIDS, offshore oil & gas was also identified as an important issue, while climate change was identified by respondents for upper-middle and lower-middle-income SIDS. In not-categorized SIDS, respondents also identified basic science & education and seabed mining as the most important issues. Maritime archeology & history and renewable energy were consistently the least important issues across income groups.

While fisheries & aquaculture was the most important issue in lower-middle and low-income non-SIDS, basic science was the most important among the others. Overall, conservation & protection was the second most important issue and was included in the top three issues of each income group except lower-middle-income non-SIDS. Telecommunication, maritime archeology & history, and renewable energy were consistently less important issues across categories, selected on average by only 1-3% of the respondents.

3.3 Deep-Sea Challenges

What are the top three challenges to deep-sea exploration and research in your GeoArea? (Q33)

Respondents were asked to select up to three deep-sea exploration and research challenges that they consider most important for their GeoArea from a list of the following options: funding, access to vessels, access to deep submergence vehicles, access to deep-sea sensors, access to data tools, scalability of technologies, human capacity/knowledge to do deep-sea research, lack of connections with other deep-sea researchers; they were also allowed to enter free-text if a challenge was not an option.

Among SIDS, funding (29%) and human capacity (25%) were the most important challenges (Table 3). Across non-SIDS GeoAreas, funding (29%), access to vessels (17%), and access to DSVs (16%) were the most important challenges.

Table 3

Income Group	**Most important deep-sea challenges identified by respondents**
SIDS: High	Funding (31%) Access to vessels (22%) Human capacity (20%)
SIDS: Upper-middle	Funding (29%) Human capacity (29%) Access to vessels (11%)
SIDS: Lower-middle	Funding (25%) Human capacity (25%) Access to vessels (11%) Access to DSVs (11%)
SIDS: Low	NR
SIDS: Not-categorized	Funding (33%) Human capacity (33%) Access to DSVs (17%)
Non-SIDS: High	Funding (31%) Access to vessels (19%) Access to DSVs (17%)
Non-SIDS: Upper-middle	Funding (30%) Access to DSVs (19%) Access to vessels (19%) Human capacity (13%)
Non-SIDS: Lower-middle	Funding (26%) Human capacity (19%) Access to DSVs (15%)

Non-SIDS: Low	Funding (27%) Human capacity (18%) Access to vessels (16%)
Non-SIDS: Not-categorized	Funding (31%) Access to vessels (17%) Human capacity (11%) Lack of connection (11%)

Funding and human capacity were among the most important challenges in every SIDS income group. Access to vessels was among the top challenges in high, upper-middle, and lower-middle-income SIDS. In lower-middle and not-categorized SIDS, respondents identified access to deep submergence vehicles as one of the top challenges.

Funding was the most important challenge in each non-SIDS income group. Access to vessels was identified as one of the top challenges by all income groups except lower-middle-income non-SIDS, and access to deep submergence vehicles was one of the top challenges in high, upper-middle, and lower-middle-income non-SIDS. Notably, lack of connections with other deep-sea researchers was identified as one of the top challenges by not-categorized non-SIDS, the only income group to do so.

> "For us to effectively develop and conduct research and monitoring in the Palau National Marine Sanctuary, we need access to readily available vessels that are able to travel offshore for multiple days. In addition, we need support to be able to cover fuel and crew costs."
>
> – Respondent for Palau, Micronesia

3.4 Deep-Sea Opportunities

What are you most excited about in the next 5-10 years for deep-sea exploration and research in your GeoArea? (Q34)

Respondents were asked to select up to three opportunities in the next 5-10 years that they were most excited about for their GeoArea from a list of the following options: technology that can go deeper, less expensive data collection technologies, better/more precise data collection technologies, scalable platforms & sensors, better *data access and analysis tools, training opportunities, and networking/connecting with others; they were also allowed to enter free-text if an opportunity was not an option.*

Training opportunities (22% of all selections), less expensive data collection technology (16%), and better data access and analysis tools (15%) were identified as the most exciting opportunities by respondents for SIDS (Table 4). Respondents for non-SIDS identified training opportunities (17% of all selections), less expensive data collection technology (16%), and networking (14%) as the most exciting opportunities.

Table 4

Income Group	**Most exciting opportunities identified by respondents**
SIDS: High	Less expensive data collection technology (24%) Training opportunities (21%) Better data access and analysis tools (13%)
SIDS: Upper-middle	Training opportunities (22%) Better data access and analysis tools (16%) More precise data collection technology (16%)
SIDS: Lower-middle	Training opportunities (22%) Better data access and analysis tools (16%) Networking/connecting with others (15%)
SIDS: Low	NR
SIDS: Not-categorized	Training opportunities (19%) More precise data collection technology (19%) Better data access and analysis tools (14%) Less expensive data collection technologies (14%) Networking/connecting with others (14%) Technology that can go deeper (14%)
Non-SIDS: High	Less expensive data collection technology (20%) Technology that can go deeper (14%) Scalable platforms & sensors (14%) More precise data collection technology (14%)
Non-SIDS: Upper-middle	Training opportunities (22%) Less expensive data collection technology (16%) Networking/connecting with others (15%)

Non-SIDS: Lower-middle	Training opportunities (20%) Networking/connecting with others (15%) Less expensive data collection technology (15%)
Non-SIDS: Low	Training opportunities (19%) Better data access and analysis tools (16%) Technology that can go deeper (16%)
Non-SIDS: Not-categorized	Training opportunities (19%) Better data access and analysis tools (17%) Better/more precise data collection technology (14%) Less expensive data collection technologies (14%) Networking/connecting with others (14%)

Training opportunities was the most exciting prospect identified by respondents for SIDS in every income group except high-income SIDS, which ranked it second. Respondents in high-income SIDS were most excited about less expensive data collection technology, followed by training opportunities. More precise data collection technology and training opportunities were viewed as equally important in not-categorized SIDS.

Training opportunities were the most exciting prospect for all non-SIDS income groups except high-income. Respondents for high-income non-SIDS were the most excited about less expensive data collection technologies. They were also the only group to identify scalable platforms & sensors as a top opportunity. While networking was the third most exciting opportunity in all income groups combined, and in some categories individually, it was the least exciting opportunity for respondents for high-income non-SIDS.

4. Status of Deep-Sea Exploration & Research

4.1 Highlights

- **Importance** | More than half of respondents for SIDS agreed that deep-sea exploration and research was important in their GeoArea. Approximately half of respondents for non-SIDS agreed that deep-sea exploration and research was considered important in their GeoArea, with most agreement in low-income non-SIDS.
- **Technology** | More than three-quarters of respondents for SIDS disagreed that they had in-country technology to conduct deep-sea exploration and research, including all respondents for not-categorized SIDS. Except for high-income non-SIDS, respondents for all non-SIDS income groups disagreed that they had in-country technology to conduct deep-sea exploration and research.
- **Expertise** | Nearly two-thirds of respondents for SIDS disagreed that they had in-country expertise to conduct deep-sea exploration and research, including all respondents for not-categorized SIDS. More than

half of respondents for non-SIDS agreed that they had in-country expertise to conduct deep-sea exploration and research, with the most agreement in high-income non-SIDS.

4.2 Importance, Technology, & Expertise

How would you assess the status of deep-sea (>200 m) exploration and research in your GeoArea? (Q4)
Survey respondents were asked to assess the status of deep-sea exploration and research in their GeoArea by stating to what extent they agreed with the following statements on a five-point scale from strongly disagree to strongly agree:

1. *Deep-sea exploration and research are considered important in my GeoArea.*
2. *We have in-country technology to conduct deep-sea exploration and research.*
3. *We have in-country expertise to conduct deep-sea exploration and research.*

Overall, 55% of respondents for SIDS agreed that exploration and research were considered important in their GeoArea (Figure 8A). However, 79% of respondents disagreed that they have the in-country technology to conduct deep-sea exploration and research (Figure 8B), and 64% of respondents disagreed that they have the in-country expertise to conduct deep-sea exploration and research (Figure 8C).

Among non-SIDS, 147 respondents (51%) agreed or strongly agreed that exploration and research were considered important in their GeoArea (Figure 8A). However, 125 respondents (44%) disagreed that they have the in-country tools/technology to conduct deep-sea exploration and research (Figure 8B). More than half of respondents for non-SIDS (59%) agreed that they have the in-country expertise to conduct deep-sea exploration and research (Figure 8C).

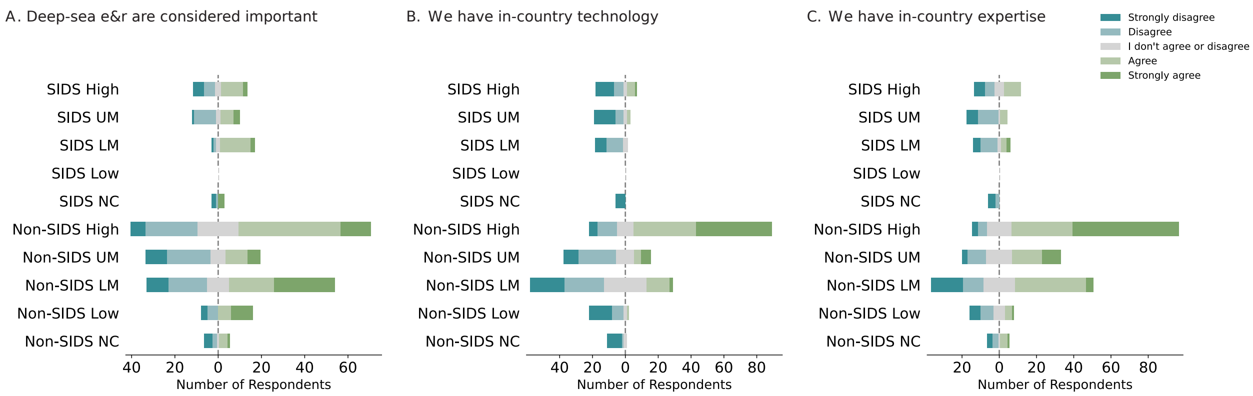


Figure 8
Deep-Sea Importance, Technology, & Expertise
(A) Number of respondents who agreed (green) or disagreed (blue) that deep-sea exploration and research is considered important in their GeoArea, by income group. **(B)** Number of respondents who agreed (green) or disagreed (blue) that their GeoArea has in-country deep-sea tools and technology, by income group. **(C)** Number of respondents who agreed (green) or disagreed (blue) that their GeoArea has in-country deep-sea expertise, by income group.

While fewer than half of respondents for high-income SIDS (48%) said that deep-sea exploration and research was considered important in their GeoArea, they also had the most agreement among SIDS that they had in-country technology (24%) and expertise (36%) to conduct such work, although these rates are still quite low. Respondents for upper-middle-income SIDS had the lowest agreement (41%) that deep-sea exploration and research was considered important in their GeoArea; 9% agreed that they had deep-sea tools, and 18% agreed that they had in-country expertise. While lower-middle-income SIDS had the highest agreement that deep-sea exploration and research was considered important in their GeoArea (80%), 25% of respondents said that there was in-country deep-sea expertise, and no respondents agreed that they had in-country deep-sea tools. Half of the respondents for not-categorized SIDS said that deep-sea exploration and research was considered important in their GeoArea, but none agreed that they had in-country tools or expertise.

Low-income non-SIDS had the largest number of respondents (67%) agreeing that deep-sea exploration and research was important in their location, followed by those in the lower-middle and high-income non-SIDS (56% and 55%, respectively). Upper-middle-income and not-categorized non-SIDS had more respondents disagreeing (50% and 57%, respectively) on the importance of deep-sea exploration and research in their location. Low-income and not-categorized non-SIDS had few to no respondents agreeing that they have the in-country tools/technology to conduct deep-sea exploration and research. These numbers increased to 18% and 19% of respondents for lower and upper-middle-income non-SIDS, respectively. Seventy-six percent of the respondents for high-income non-SIDS were in agreement that they had in-country tools/technology. More respondents across non-SIDS (59%) generally agreed they had expertise to conduct deep-sea exploration and research in their GeoArea. Eighty-one percent of the respondents for high-income non-SIDS agreed, followed by upper and lower-middle non-SIDS, both with 48-49% of their respondents.

4.3 Deep-Sea Capacity Status Parameters

Based on the survey results of Question 4 above, we aggregated the responses for which respondents agreed or strongly agreed that (1) deep-sea exploration and research are considered important in their GeoArea, (2) they have in-country deep-sea technology, and (3) they have in-country deep-sea expertise. These data were used to calculate three Deep-Sea Capacity Status Parameters (SPs) to compare respondents' perceptions of the relative importance of deep-sea exploration and research in their GeoArea, and the existence of deep-sea technology and expertise in their GeoArea. The SPs were calculated for each subregion of the world.

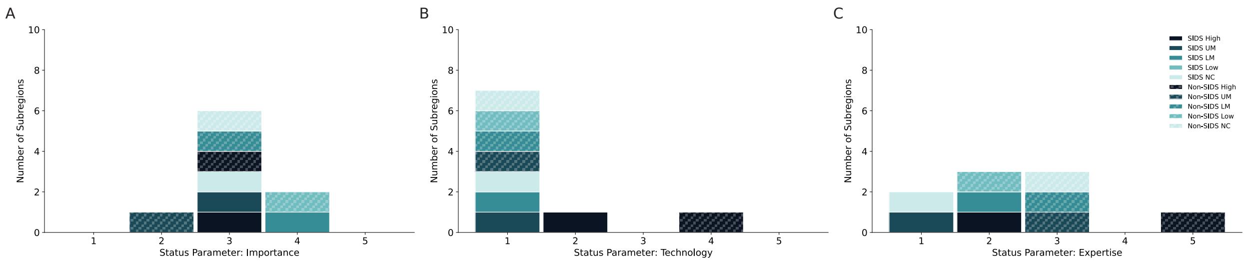


Figure 9
Deep-Sea Capacity Status Parameters
(A) Number of income group with each Importance Status Parameter. **(B)** Number of income groups with each Technology Status Parameter. **(C)** Number of income groups with each Expertise Status Parameter.

The **Importance Status Parameter (Importance SP)** assessed the respondent-reported importance of deep-sea exploration and research in their GeoArea (Figure 9A). Lower-middle-income SIDS had the highest average Importance SP of 4. All other SIDS income groups had a moderate Importance SP of 3, indicating that most respondents for all SIDS income groups thought that deep-sea exploration and research was considered moderately important in their GeoArea. Low-income non-SIDS had the highest average Importance SP of 4, followed by high, lower-middle-income, and not-categorized non-SIDS, which had an SP of 3. Upper-middle-income non-SIDS had a low Importance SP of 2. This result indicated non-SIDS had a range of opinions regarding the importance of deep-sea exploration and research in their GeoArea.

The **Technology Status Parameter (Technology SP)** assessed the respondent-reported existence of deep-sea tools and technology in their GeoArea (Figure 9B). All four SIDS income groups had a low Technology SP: high-income SIDS had a Technology SP of 2, and all other groups had the lowest SP of 1. With the exception of high-income non-SIDS, all non-SIDS income groups had a low Technology SP of 1. High-income non-SIDS were the only group with a high Technology SP of 4. The Technology SPs of SIDS were lower than most non-SIDS, and were the lowest of the three status parameters globally.

The **Expertise Status Parameter (Expertise SP)** assessed the respondent-reported existence of deep-sea expertise in their GeoArea (Figure 9C). All four SIDS income groups had a low Expertise SP, indicating that respondents thought that there was little to no in-country expertise required to carry out deep-sea exploration and research in their GeoArea. High and lower-middle-income SIDS had an Expertise SP of 2, while upper-middle-income and not-categorized SIDS had the lowest Expertise SP of 1. High-income non-SIDS had an average Expertise SP of 5, the highest of all income groups. All other non-SIDS income groups had Expertise SPs of 2 or 3. As for the Technology SPs, the Expertise SPs of non-SIDS were higher than in SIDS.

4.4 Status Parameter Groups

The Deep-Sea Capacity Status Parameters (SPs) are based on respondents' opinions of their GeoArea and are calculated on a scale of 1 for low agreement to 5 for high agreement with each statement (Data Collection & Analysis). SPs vary by subregion, which are classified into six SP Groups based on the level of agreement with each of the status parameters (Table 5). Using the SP Groups, we can evaluate respondents' perceptions of the importance of and existence of in-country resources for deep-sea exploration and research at the subregional level.

Table 5

SIDS SP Group	Importance	Tech	Expertise	Income Groups
I	Mid	High	High	Non-SIDS high-income
II	Low-mid	Low	Mid	Non-SIDS upper-middle-income Non-SIDS lower-middle-income Non-SIDS not-categorized
III	High	Low	Low	Non-SIDS low-income SIDS lower-middle-income
IV	Mid	Low	Low	SIDS high-income SIDS upper-middle-income SIDS not-categorized

All SIDS income groups were in SP Groups III and IV, indicating generally low in-country deep-sea technology and expertise. No respondents for low-income SIDS responded to these questions, and this group is therefore not included in this assessment.

Lower-middle-income SIDS were in SP Group III because more respondents for this group expressed that deep-sea exploration and research was considered important than respondents for other SIDS income groups. Lower-middle and low-income non-SIDS GeoAreas were also in this SP Group.

All other SIDS income groups were in SP Group IV, indicating moderate agreement that deep-sea exploration and research were considered important in their GeoArea, and low agreement that they had in-country deep-sea tools and expertise. There were no non-SIDS GeoAreas in this SP Group.

Respondents for high-income non-SIDS expressed that deep-sea exploration and research was considered important in their GeoArea and that they had technology and expertise to conduct deep-sea exploration and research relative to other groups. Respondents for the other non-SIDS income groups expressed intermediate opinions and belonged to SP groups II or III. Low-income non-SIDS had lower SP parameters than all other non-SIDS income groups but were equal to or higher than all SIDS income groups.

"About time to commence work in this area as we have the Government submarine cable for telecommunications in the country. No deep sea marine scientists to monitor the impacts of this."

– Respondent for Vanuatu, Melanesia

5. Deep-Sea Capacity Presence, Accessibility, & Satisfaction

5.1 Highlights

- **Presence** | High-income SIDS had the highest average presence of organizations and diversity of marine industries, vessels, DSVs, sensor systems, and data tools among SIDS GeoAreas. Low-income SIDS had the lowest average presence of marine infrastructure and deep-sea technology. Among non-SIDs, high-income GeoAreas had the highest average presence of organizations and diversity of marine industries, vessels, DSVs, sensor systems, and data tools. Low-income and not-categorized non-SIDS had the lowest average presence of marine infrastructure and deep-sea technology.
- **Accessibility** | High and lower-middle-income SIDS had the highest average access to different types of vessels, DSVs, sensor systems, and data tools and were closely followed by upper-middle-income and not-categorized SIDS. High-income non-SIDS had the highest access to different types of vessels, DSVs, sensor systems, and data tools, while all other categories had generally low access.
- **Satisfaction** | Not-categorized SIDS had the highest average satisfaction with vessels, DSVs, sensor systems, and data tools. Lower-middle-income SIDS had the lowest average satisfaction with the deep-sea technology to which respondents had access. High-income non-SIDS had the highest average satisfaction with vessels, DSVs, sensor systems, and data tools. Not-categorized non-SIDS had the lowest average satisfaction with the deep-sea technology to which respondents had access.

5.2 Presence, Accessibility, & Satisfaction Indices

We assessed organizations, industries, vessels, DSVs, sensors, and data tools using research to identify the presence of capacity in each GeoArea and survey responses to identify accessibility to and satisfaction of vessels, DSVs, sensors, and data tools in each subregion. We used this data to calculate three Deep-Sea Capacity Indices (DSC Indices) to enable comparisons between locations in terms of the presence of, access to, and satisfaction with the various types of capacities.

In contrast to the Status Parameters, which are focused on the overall respondent perception of their GeoArea, the DSC Indices represent extensive research on marine infrastructure and deep-sea technology presence, survey respondents' access to specific types of deep-sea technology, and respondents' satisfaction with the technology to which they have access. The DSC Indices, therefore, are an initial attempt to assess the relative ability of researchers to conduct deep-sea exploration and research.

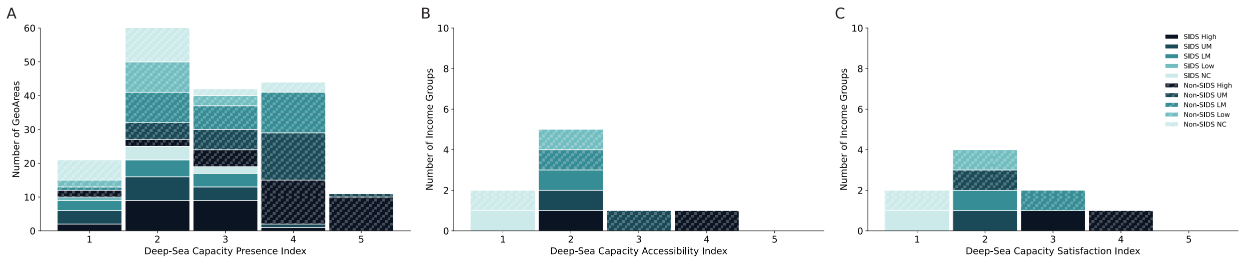


Figure 10
Deep-Sea Capacity Indices
(A) Number of GeoAreas with each DSC Presence Index, by income group. High DSCPIs indicate higher diversity of capacity types present in each GeoArea. **(B)** Number of income groups with each DSC Accessibility Index. High DSCAIs indicate higher access to more types of deep-sea capacities. **(C)** Number of income groups with each DSC Satisfaction Index. High DSCSIs indicate more overall satisfaction with the deep-sea capacities to which respondents had access.

The **Deep-Sea Capacity Presence Index (DSCPI)** assessed the research-based presence of organizations and diversity of marine industries, vessels, DSVs, sensor systems, and data tools in each GeoArea; higher values indicate higher diversity of capacity types present in each GeoArea (Figure 10A).

High-income SIDS had the highest DSCPIs, followed by not-categorized SIDS. Low-income SIDS had the lowest DSCPIs of all SIDS. High-income non-SIDS had the highest average DSCPIs, followed by upper-middle and lower-middle-income non-SIDS. Low-income and not-categorized non-SIDS had the lowest DSCPIs of all non-SIDS. In general, the average DSCPI for non-SIDS was higher than the average DSCPI for SIDS, indicating that non-SIDS had greater deep-sea capacity infrastructure than SIDS.

None of the SIDS had the highest DSCPI of 5, but two (Dominican Republic and the Bahamas) had a high average DSCPI of 4. Eighteen percent of SIDS had the lowest DSCPIs of 1. Upper-middle and high-income

SIDS had 5-6% of their GeoAreas with a high DSCPI of 4, while the other income groups had none, and high-income SIDS also had the lowest fraction of GeoAreas with low DSCPIs of 1 or 2 (53%). Conversely, lower-middle-income and not-categorized SIDS had a large fraction of GeoAreas with low DSCPIs of 1 or 2 (67%). The low-income SIDS, Guinea-Bissau, had the lowest overall DSCPI of 1.

Eleven non-SIDS had the highest DSCPI of 5, ten in high-income non-SIDS and one upper-middle-income non-SIDS. Eleven non-SIDS, more than half not-categorized, had the lowest overall DSCPIs of 1. The most common DSCPI in high, upper- and lower-middle-income non-SIDS (41-54%) was 4, while it was 2 in low-income and not-categorized non-SIDS (64 and 52%, respectively).

The **Deep Sea Capacity Accessibility Index (DSCAI)** assessed the respondent-reported access to different types of vessels, DSVs, sensor systems, and data tools in each subregion; higher values indicate higher access to more types of these deep-sea capacities in each subregion (Figure 10B).

All SIDS income groups had a low overall DSCAI of 2, except not-categorized SIDS, which had the lowest DSCAI of 1.

High-income non-SIDS had a high overall DSCAI of 4, and upper-middle-income non-SIDS had a moderate overall DSCAI of 3. All other non-SIDS income groups had low DSCAIs of 1 or 2. Overall, the average DSCAI for non-SIDS was higher than for SIDS, indicating more access to deep-sea tools and resources in non-SIDS than in SIDS.

The **Deep Sea Capacity Satisfaction Index (DSCSI)** assessed the respondent-reported satisfaction with vessels, DSVs, sensor systems, and data tools in each subregion, based on several factors, including cost, availability, and capabilities; higher values indicate more overall satisfaction with the deep-sea capacities to which respondents had access in each subregion (Figure 10C).

Not-categorized SIDS had the lowest average DSCSI of 1, while high-income SIDS had the highest average DSCSI among SIDS with a moderate 3 out of 5.

High-income non-SIDS had a high overall DSCSI of 4, and lower-middle-income non-SIDS had a moderate overall DSCSI of 3. All other non-SIDS income groups had low DSCSIs of 1 or 2. Overall, satisfaction with deep-sea capacities was higher in non-SIDS than SIDS.

5.3 Deep-Sea Capacity Groups

Using the Deep-Sea Capacity Indices, we identified four Deep-Sea Capacity Index Groups (DSC Groups) of subregions based on similarities concerning the presence of marine infrastructure and deep-sea technology, access to technology, and satisfaction with the technology available (Table 6).

Table 6

SIDS DSC Group	Presence	Access	Satisfaction	Income Groups
I	High	High	High	Non-SIDS high-income
II	Mid	Low-mid	Low-mid	Non-SIDS upper-middle-income Non-SIDS lower-middle-income
III	Low-mid	Low	Low-mid	Non-SIDS low-income SIDS high-income SIDS upper-middle-income SIDS lower-middle-income
IV	Low-mid	Low	Low	Non-SIDS not-categorized SIDS not-categorized

High-income SIDS had the highest combination of presence of, access to, and satisfaction with, marine infrastructure and deep-sea technology among SIDS. Overall, SIDS were split between DSC Groups III and IV, demonstrating low levels in the presence of, access to, and satisfaction with marine infrastructure and deep-sea technology. Levels of presence, access, and satisfaction were generally low such that even high-income SIDS had similar levels to the lower-income non-SIDS GeoAreas.

High-income non-SIDS had the highest combination of the presence of, access to, and satisfaction with, marine infrastructure and deep-sea technology among non-SIDS GeoAreas. This income group was followed by upper-middle and lower-middle-income non-SIDS in DSC Group II with a mid-level presence of deep-sea infrastructure and a low-to-mid level of access to and satisfaction with deep-sea tools. Low-income non-SIDS were most similar to high and middle-income SIDS in DSC Group III, with low-to-mid presence of and satisfaction with infrastructure and less access to deep-sea tools. Not-categorized non-SIDS had the least presence of, access to, and satisfaction with marine infrastructure and deep-sea technology (DSC Group IV), similar to not-categorized SIDS.

6. Organizations & Industries

6.1 Highlights

- **Organizations** | In SIDS, we identified 366 deep-sea and marine organizations; 100 (27%) were universities and research laboratories, 179 (49%) were government agencies and ministries, and 87 (24%) were other organizations. In non-SIDS GeoAreas, we identified 1,682 deep-sea and marine organizations; 664 (39%) were universities and research laboratories, 606 (36%) were government agencies and ministries, and 412 (24%) were other organizations.

- **Industries** | In SIDS, the most common types of industries found were fisheries & aquaculture, followed by marine transportation and tourism. In non-SIDS, the most common industry was marine transport, followed by fisheries & aquaculture and conservation. Deep-sea mining was the least active industry cited by respondents for both SIDS and non-SIDS.

6.2 Organizations

Which universities and/or research labs, government agencies/ministries, and other organizations in your GeoArea study the deep sea or deal with deep-sea issues? (Q7-9, Q7-9R)

We surveyed respondents and conducted manual research to identify deep-sea and marine organizations, including universities and research laboratories, government agencies and ministries, and other organizations. Each research and survey data source had a limit of 5 organizations per type (lab, government, or other) per GeoArea. Overall, 343 deep-sea and marine organizations across SIDS were found through manual research alone (76%), 65 were recorded from the survey alone (14%), and 46 were identified by both research and the survey (10%).

We identified 366 deep-sea and marine organizations throughout SIDS; 100 were universities and research laboratories (27% of the total), 179 were government agencies and ministries (49%), and 87 were other organizations (24%) (Figure 11A). The largest number of organizations, all types combined, were found in upper-middle-income (124) and the fewest in low-income SIDS (6). When normalized by the number of organizations per GeoArea, low-income SIDS had the highest normalized number of organizations *per GeoArea*, while high-income SIDS had the lowest.

We identified 1,682 deep-sea and marine organizations throughout non-SIDS GeoAreas; 664 were universities and research laboratories (39% of the total), 606 were government agencies and ministries (36%), and 412 were other organizations (24%) (Figure 11A). The largest number of organizations, all types combined, were found in high-income (538) and the fewest in low-income non-SIDS (158). Both low-income and not-categorized non-SIDS had more government agencies and ministries, while the other non-SIDS income groups had more universities and research laboratories.

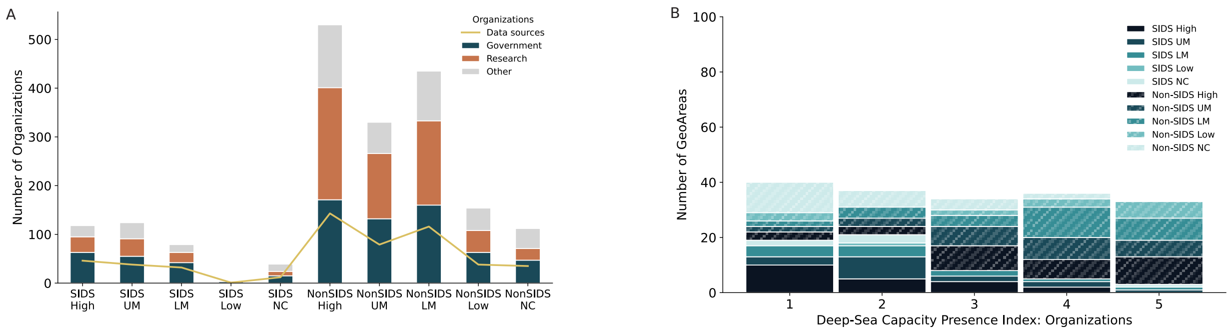


Figure 11
Organizations
(A) Number of academic institutions (blue), government agencies (orange), and other organizations (grey) based in each income group that do marine and/or deep-sea work. Number of survey and research data sources for each income group (yellow line). **(B)** Number of GeoAreas with each Organizational Deep-Sea Capacity Presence Index, by income group. Higher Org DSCPIs indicate a higher abundance of organizations present in each GeoArea.

The Organizational Deep-Sea Capacity Presence Index (Org DSCPI) assessed the research-based presence of research, government, and other marine organizations in each GeoArea; higher values indicate a higher abundance of organizations present in each GeoArea.

Using the Org DSCPI for SIDS, we found that all SIDS income groups had a low average Org DSCPI of 2 (Figure 11B). Three SIDS (5%), Martinique, Comoros, and the Dominican Republic, had an Org DSCPI of 5 (i.e., many organizations were present), the highest among SIDS. Upper-middle-income SIDS had the highest proportion of high Org DSCPI values, with 19% of GeoAreas with an organization DSCPI of 4 or 5, followed by the lower-middle and not-categorized SIDS. In not-categorized SIDS, 83% of GeoAreas had an Org DSCPI of 1 or 2.

For non-SIDS, we found that all but one non-SIDS income group had a high average Org DSCPI of 4 (Figure 11B). Not-categorized non-SIDS had the low Org DSCPI of 2, similar to all SIDS income groups. Thirty non-SIDS GeoAreas (24%) had an organization DSCPI of 5. Low-income non-SIDS had the highest proportion of high organizational DSCPI values, with six GeoAreas (43%) with an organization DSCPI of 5, followed by high-income non-SIDS which had ten GeoAreas with a DSCPI of 5 (31%). Not-categorized non-SIDS had 74% of GeoAreas with an organizational DSCPI of 1 or 2, the highest proportion of low index among all non-SIDS income groups.

On average, SIDS had a lower presence of marine and deep-sea organizations than non-SIDS.

6.3 Marine Industries

What marine industries exist in each GeoArea? (Q10R)

We researched whether or not ten different marine industries were present in each GeoArea from a list of the *following options: fisheries & aquaculture, marine transportation, tourism, conservation & protection, offshore oil & gas, safety & surveillance, marine construction, marine research & development, ocean renewable energy, and deep-sea mining.*

The most common industries found across SIDS were fisheries & aquaculture (present in 98% of GeoAreas), followed by marine transportation (96%) and tourism (95%) (Figure 12A). The most common industry found across non-SIDS was marine transport, present in all GeoAreas, followed by fisheries & aquaculture (98%) and conservation (96%).

Deep-sea mining was the least active industry. While no SIDS had yet developed this industry, it was found to be in prospect or under development in some. Deep-sea mining was the least active industry in non-SIDS, only present in eight (6%), and is in prospect or under development in additional non-SIDS GeoAreas.

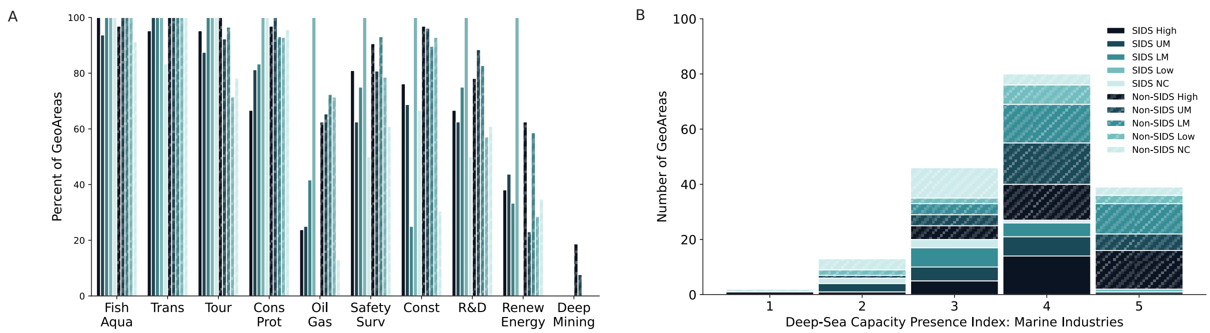


Figure 12
Marine Industries: Research
(A) Percent of GeoAreas in each income group in which each type of marine industry was found: fisheries & aquaculture (Fish Aqua), marine transportation (Trans), tourism (Tour), conservation & protection (Cons Prot), offshore oil & gas (Oil Gas), safety & surveillance (Safety Surv), research & development (R&D), renewable energy (Renew Energy), and deep-sea mining (Deep Mining). **(B)** Number of GeoAreas with each Industry Deep-Sea Capacity Presence Index, by income group. High Industry DSCPIs indicate high diversity of industry types present in each GeoArea.

The Industry Deep-Sea Capacity Presence Index (Industry DSCPI) assessed the research-based presence of types of marine industries in each GeoArea; higher values indicate higher diversity of industry types present in each GeoArea.

Using the Industry DSCPI for SIDS, we found that the average Industry DSCPI is high and comparable to non-SIDS GeoAreas, making it the second most present capacity for SIDS (Figure 12B). The highest average Industry DSCPI of 5 was found for low-income SIDS (i.e., many types of industries were present), followed by high-income SIDS with a DSCPI of 4. All other income groups had a moderate DSCPI of 3. We found that only two SIDS (4%) had the maximum Industry DSCPI of 5, but 27 (48%) had a DSCPI of 4. Therefore, approximately half of the assessed SIDS had highly diverse marine industries.

Among non-SIDS, we found that all income groups had a high Industry DSCPI of 4, except not-categorized non-SIDS, which had a moderate Industry DSCPI of 3. Thirty-seven GeoAreas (30%) had the maximum Industry DSCPI of 5 (i.e., many types of industries were present), and 53 (43%) had a DSCPI of 4 (Figure 12B). Therefore, more than 70% of the assessed non-SIDS GeoAreas had highly diverse marine industries. Only one non-SIDS, Palestine, had a very low Industry DSCPI of 1 (1%).

What marine industries exist in your GeoArea? (Q10)

Survey respondents were asked to select all the marine industries in their GeoArea from a list of the following options: fisheries & aquaculture, marine transportation, tourism, conservation & protection, offshore oil & gas, safety & surveillance, marine construction, marine research & development, ocean renewable energy, deep-sea mining, or none of the above; they were also allowed to enter free-text if a marine industry in their GeoArea was not an option.

The majority of respondents for SIDS selected fisheries & aquaculture (96%), marine transportation (89%), and tourism and conservation (each selected by 79% of respondents) (Figure 13). The most selected industries by respondents for non-SIDS were fisheries & aquaculture (95% of selections), marine transportation (87%), and tourism (70%).

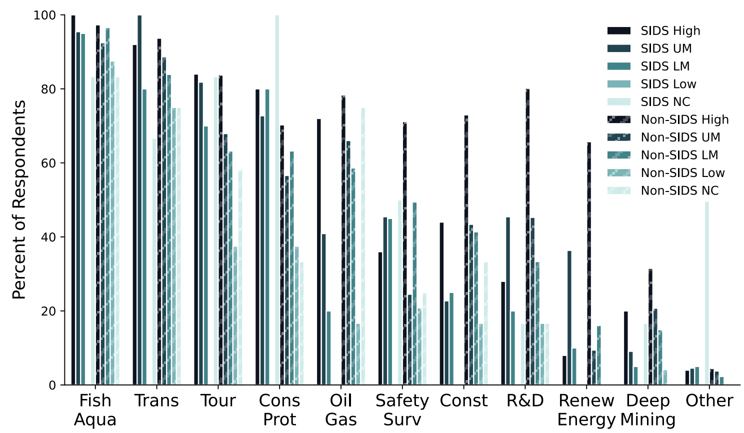


Figure 13
Marine Industries: Survey
Percent of survey respondents for each income group who indicated that each marine industry was present in their GeoArea. Industries included: fisheries & aquaculture (Fish Aqua), marine transportation (Trans), tourism (Tour), conservation & protection (Cons Prot), offshore oil & gas (Oil Gas), safety & surveillance (Safety Surv), research & development (R&D), renewable energy (Renew Energy), deep-sea mining (Deep Mining), or Other.

For SIDS, we found the most significant differences in research and survey results for marine R&D, marine construction, and safety & surveillance; significantly more of these industries were found in research than identified by survey respondents. Conversely, respondents selected deep-sea mining and offshore oil & gas considerably more than the number of such active industries found through research. In fact, no SIDS had an active deep-sea mining industry, but survey responses showed that the topic and prospect for such an industry was important. Steelwork was another type of industry listed by respondents. Some respondents mentioned the possibility of deep-sea mining, while others mentioned that their SIDS abandoned these projects.

For non-SIDS, we found the most significant differences in research and survey results for conservation & protection, marine R&D, marine construction, and safety & surveillance; significantly more of these industries were found in research than identified by non-SIDS survey respondents. Conversely, respondents selected deep-sea mining considerably more than the number of such active industries found through research. Other types of industries listed by respondents for non-SIDS included mining on the continental shelf, seafloor cabling for energy and communication, tidal energy, biofuel and ocean-based carbon capture. Several respondents for non-SIDS noted that while deep-sea mining did not currently exist in their GeoArea, it was a "big center of interest."

7. Vessels

7.1 Highlights

- **Importance** | Seventy-one percent of respondents for SIDS and 81% of respondents for non-SIDS considered ships and vessels important for their work.
- **Presence** | Fishing vessels were the most present vessels in SIDS. Research vessels were the least present type of vessels found in all SIDS combined. Fishing vessels were the most present vessels in non-SIDS, followed by recreational and naval vessels.
- **Access** | The most accessible vessels across SIDS were fishing vessels, however, nearly half of respondents for SIDS reported having no access to vessels. The most accessible vessels in non-SIDS were research vessels, followed by fishing vessels.
- **Satisfaction** | Respondents for both SIDS and non-SIDS were split in opinion on vessel operation in their SIDS but were generally more dissatisfied with vessel operations than satisfied.
- **Potential Impact** | Approximately 66% of respondents for both SIDS and non-SIDS reported that increased access to vessels would have a high impact or would be transformative for their work.

7.2 Vessel Importance

How important are ships/vessels for your work? (Q11)

Respondents were asked how important ships and vessels were for their work on a five-point scale from not important to very important.

Most respondents for SIDS (71%) considered ships and vessels important for their work (Figure 14). In each income group, 65-76% of respondents for SIDS considered ships and vessels important or very important.

The majority of respondents for non-SIDS (81%) also considered ships and vessels important for their work (Figure 14). In each non-SIDS income group, 67-86% of respondents considered ships and vessels important or very important.

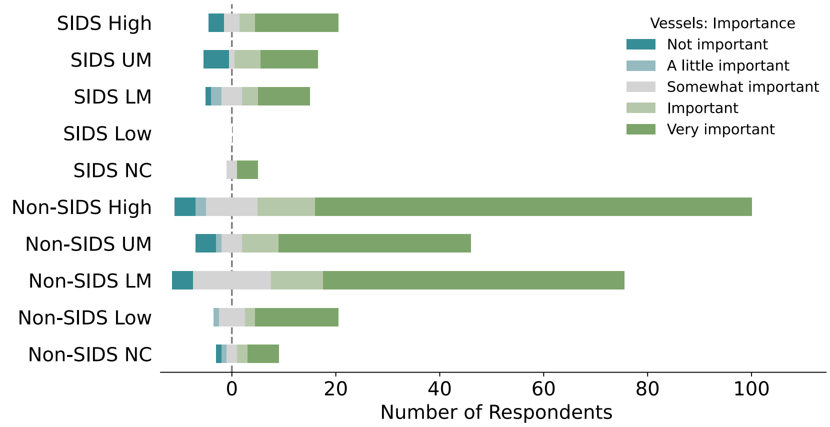


Figure 14
Vessels: Importance
Number of survey respondents for each income group who considered vessels very important or important (green) to little or not important (blue) for their work.

7.3 Vessel Presence: Research Results

What types of vessels are present in each GeoArea? (Q12R)

We researched the types of vessels present in each GeoArea, specifically if the GeoArea had research, fishing, cruise ships, recreational, traditional, or navy vessels. We recorded the presence or absence of each type of vessel, with presence meaning that at least one vessel of a given type was present in the GeoArea.

Fishing vessels were the most present type of vessel in SIDS, found in 49 GeoAreas (88%), while research vessels were the least common, found in only 25 SIDS (45%) (Figure 15A). In all SIDS income groups, fishing and recreational vessels were the most common. Cruise ships were the least common in upper-middle, high-income, and not-categorized SIDS (0-50%), while research vessels were the least common in low and lower-middle-income SIDS (0-33%). Traditional vessels and cruise ships were the least common in high-income SIDS.

In non-SIDS, fishing vessels were also the most present type of vessel, found in 116 non-SIDS GeoAreas (94%), while cruise vessels were the least common, found in 78 GeoAreas (63%) (Figure 15A). In high-income non-SIDS, recreational vessels were present in all GeoAreas, followed by fishing vessels (97%), and research and naval vessels (88% each). In upper-middle-income non-SIDS, fishing vessels were found in 96% of GeoAreas, followed by recreational vessels (92%) and naval vessels (88%). In lower-middle and low-income non-SIDS, fishing and naval vessels were found in all GeoAreas, followed by recreational and traditional vessels. In not-categorized non-SIDS, recreational and fishing vessels were most common, followed by cruise ships and other types of vessels.

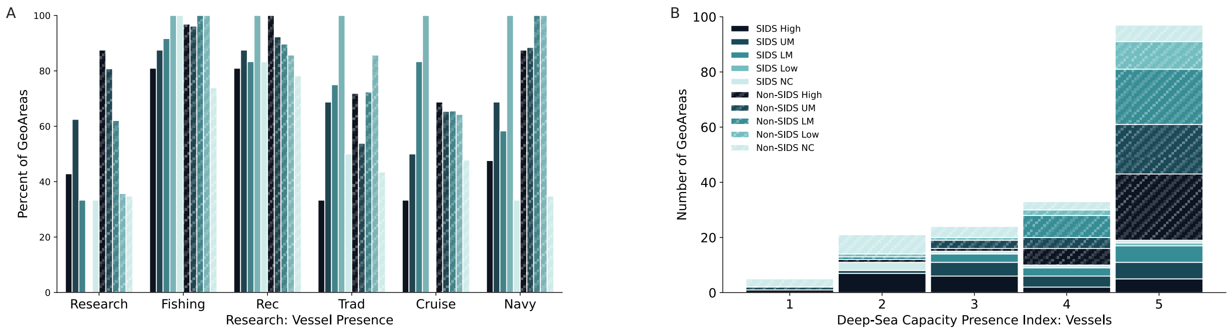


Figure 15
Vessels: Presence
(A) Percent of GeoAreas in each income group in which each type of vessel was found through research: research vessels, fishing vessels, recreational vessels (Rec), traditional vessels (Trad), cruise ships (Cruise), or navy vessels (Navy). **(B)** Number of SIDS and non-SIDS GeoAreas worldwide with each Vessel Deep-Sea Capacity Presence Index. High Vessel DSCPIs indicate higher diversity of vessel types present in each GeoArea.

The Vessel Deep-Sea Capacity Presence Index (Vessel DSCPI) assessed the research-based presence of certain vessel types in each GeoArea; higher values indicate higher diversity of vessel types present in each GeoArea.

For SIDS, the Vessel DSCPI averaged from 3 to 5 for each income group (Figure 15B). The highest average Vessel DSCPI of 5 (i.e., many types of vessels were present) was observed for low-income SIDS, Guinea-Bissau. The lowest average Vessel DSCPI (3) was observed for high-income and not-categorized SIDS. Nineteen SIDS (34%) had the maximum Vessel DSCPI of 5; twelve (21%) had a low value of 1 or 2. Low and lower-middle-income SIDS had the most types of vessels with a Vessel DSCPIs of 4 or 5. Not-categorized had the fewest types of vessels present, with the largest percentage of GeoAreas with a low Vessel DSCPI of 2 (50%). One high-income SIDS, Puerto Rico, had a very low vessel DSCPI of 1.

For non-SIDS, the Vessel DSCPI also averaged from 3 to 5 for each income group (Figure 15B). The highest average Vessel DSCPI of 5 was observed for high, lower-middle, and low-income non-SIDS. The lowest average Vessel DSCPI was observed for not-categorized non-SIDS (3). Seventy-eight non-SIDS (63%) had the maximum Vessel DSCPI of 5; nineteen had a low Vessel DSCPI of 1 or 2 (15%). Four non-SIDS, French Guiana, Saint Barthelemy, Sint Eustatius, and Georgia, had a very low Vessel DSCPI of 1.

While vessels were the technical capacity with the most extensive presence worldwide for both SIDS and non-SIDS, non-SIDS had a higher presence of vessel types than SIDS.

7.4 Vessel Access: Survey Results

What kinds of vessels do you have access to for deep-sea work? (Q12/13)
Respondents were asked to select all types of vessels to which they had access for deep-sea work from a list of the following options: research vessels, fishing vessels, cruise ships, recreational vessels, traditional vessels, or

none of the above; they were also allowed to enter free-text if a type of vessel to which they had access was not an option.

The most accessible vessels across SIDS were fishing vessels (available to only 41% of respondents), followed by research vessels (available to 25%) (Figure 16A). Thirty-four respondents (47%) reported having no access to vessels. Vessels were the technical capacity with the most extensive *presence* in SIDS but were the technical capacity to which respondents had only the second-highest *access*, after data tools. In high-income SIDS, respondents had the most access to research vessels, while respondents for all other income groups had the highest access to fishing vessels. Approximately half of respondents for high, upper-middle, and lower-middle-income SIDS reported having no access to vessels, the most selected option in those income groups.

The most accessible vessels across and in each non-SIDS income group were research vessels (available to 58% of respondents), however, the availability of research vessels varied greatly across income groups (Figure 16A). In high-income non-SIDS, 81% of respondents had access to research vessels, while only 8% of respondents for low-income non-SIDS said that they had access to research vessels. Twenty-one percent of respondents for non-SIDS had no access to vessels. Vessels were the technical capacity with the most extensive *presence* worldwide, in general, but were the technical capacity to which respondents had only the second-highest *access*, after data tools. Cruise ships were the least accessible type of vessels across non-SIDS.

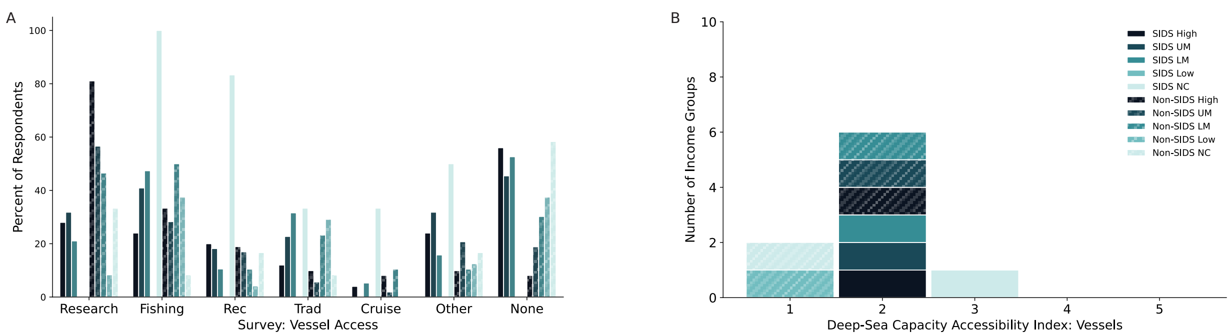


Figure 16
Vessels: Access
(A) Percent of respondents for each income group with access to each type of vessel: research vessels, fishing vessels, recreational vessels (Rec), traditional vessels (Trad), cruise ships (Cruise), other, or none of the above. **(B)** Number of income groups worldwide with each Vessel Deep-Sea Capacity Accessibility Index. High Vessel DSCAIs indicate higher respondent-reported access to vessels in their GeoArea.

The Vessel Deep Sea Capacity Accessibility Index (Vessel DSCAI) assessed the respondent-reported access to different types of vessels in each subregion; higher values indicate higher access to more types of vessels.

From the Vessel DSCAI (Figure 16B), we found that, for SIDS, no income group had the maximum Vessel DSCAI of 5. The highest Vessel DSCAI was 3 for not-categorized SIDS, followed by 2 for all other SIDS income groups. This index of 3 was also the highest across all SIDS and non-SIDS income groups.

Using the Vessel DSCAI for non-SIDS, we found that vessel accessibility was low across all income groups, which had Vessel DSCAIs of only 1 or 2 (Figure 16B).

Vessels were the technical capacity with the second-lowest accessibility worldwide. The average Vessel DSCAI for SIDS was higher than for non-SIDS.

7.5 Vessel Satisfaction

How well do the vessels meet your needs? (Q14)

Respondents were asked how satisfied they were with vessels in their GeoArea in terms of cost, availability, capabilities, size, and duration, each on a five-point scale from very dissatisfied to very satisfied. Out of 76 total respondents for SIDS, 54-56 answered these questions (71-74% response rate). Out of 287 total respondents for non-SIDS, 251-258 answered these questions (85-87% response rate).

Nearly half of respondents for SIDS (46%) were dissatisfied with vessel operations in their GeoArea (Figure 17A). They were the most dissatisfied with vessel capabilities (59% dissatisfied) (Figure 17D).

Respondents for non-SIDS were split in opinion on vessel satisfaction in their GeoArea, although they were overall more satisfied in high-income non-SIDS. Overall, 50% of respondents were satisfied with vessel size and most dissatisfied with vessel availability (48%).

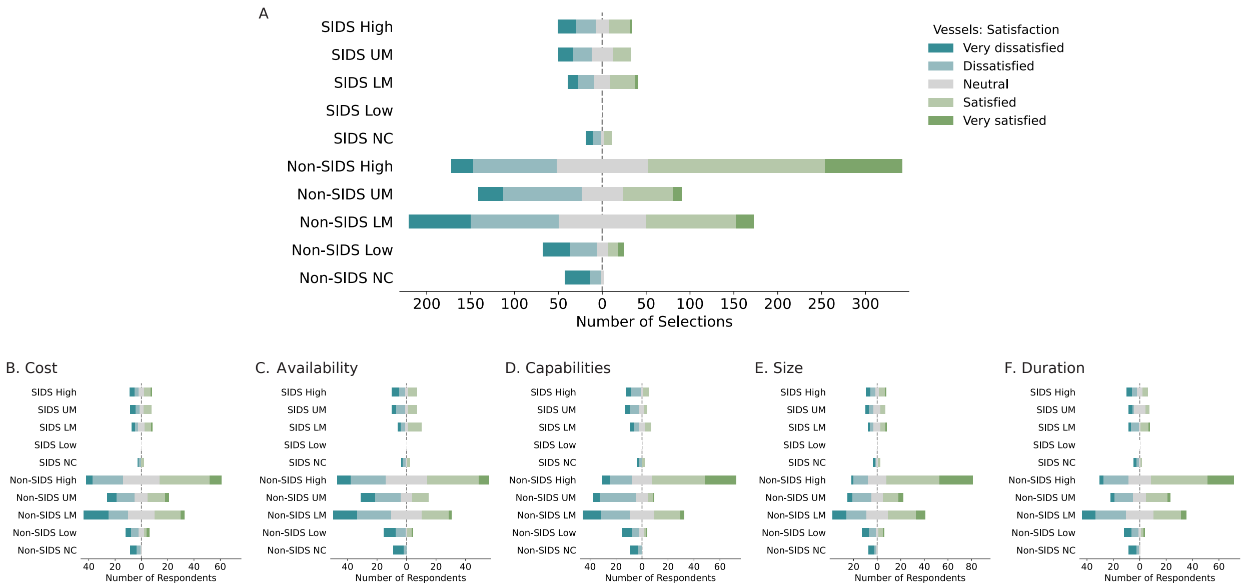


Figure 17
Vessels: Satisfaction

Number of respondents for each income group who are satisfied (green) or dissatisfied (blue) with all aspects of vessels available to them in their GeoArea **(A)**. Number of respondents for each income group who are satisfied (green) to dissatisfied (blue) with each of the aspects of vessel operation: Cost **(B)**, Availability **(C)**, Capabilities **(D)**, Size **(E)**, and Duration **(F)**.

Respondents for lower-middle-income SIDS were generally the most satisfied with vessel operation compared to other SIDS income groups. More than half of the respondents for not-categorized, upper-middle, and high-income SIDS were generally dissatisfied with vessel availability and capabilities (Figure 17C, D). Not-categorized SIDS were the most dissatisfied with cost and duration (Figure 17B, F), while upper-middle-income SIDS were the most dissatisfied with vessel size (Figure 17E). Generally, more respondents were dissatisfied than satisfied with vessel operations in high-income, upper-middle-income, and not-categorized SIDS.

Respondents for low-income and not-categorized non-SIDS were the most dissatisfied with vessel operation, especially with regard to availability and capabilities (Figure 17C, D). Respondents for high, upper- and lower-middle-income non-SIDS were also more dissatisfied with vessel availability and capabilities than other vessel attributes (Figure 17C, D). Not-categorized non-SIDS were the most dissatisfied with all attributes (88-100%), while high-income non-SIDS were the most satisfied (41-63%).

The Vessel Deep Sea Capacity Satisfaction Index (Vessel DSCSI) assessed the respondent-reported satisfaction of vessels based on several factors, including cost, availability, and capabilities in each subregion; higher values indicate more overall satisfaction with vessels to which respondents had access.

While satisfaction with vessels was generally low among SIDS, vessels were the technical capacity with which respondents for SIDS were second-most satisfied, along with data tools.

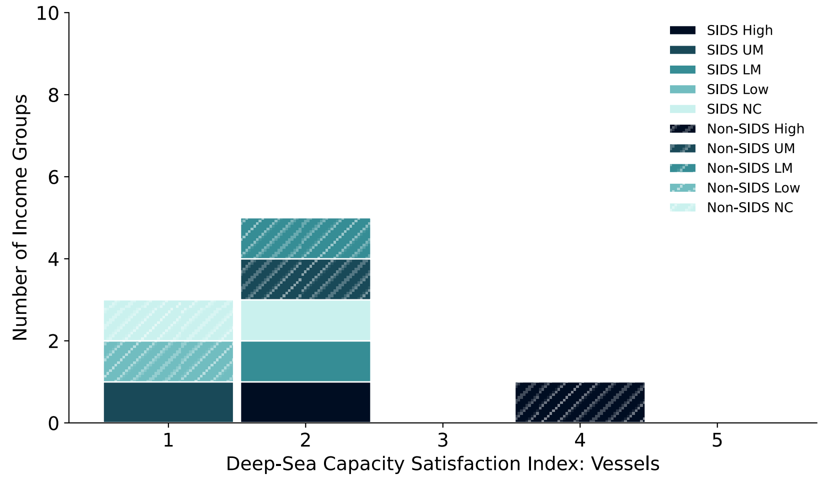


Figure 18
Vessels: Satisfaction
Number of income groups worldwide with each Vessel Deep-Sea Capacity Satisfaction Index. High Vessel DSCSIs indicate high respondent-reported satisfaction with the vessels to which they have access.

From the Vessel DSCSI (Figure 18), we found that, on average, respondents for SIDS were less satisfied with vessels than respondents for non-SIDS. Except for upper-middle-income SIDS, which had the lowest DSCSI of 1, all other SIDS income groups had a low DSCSI of 2. One of the most significant factors respondents from multiple SIDS noted as impacting how well vessels in their GeoArea met their needs was the limited maintenance and appropriate equipment for research and deep-sea work. Other considerations included the expense of operation and limited access to the vessels themselves, especially large motored vessels or appropriate equipment and crew on board those available to execute multiple-day missions offshore. Other factors included the high cost of operation and low funding levels, and the lack of national infrastructure like docking space or safe harbors. Existing vessels and infrastructure belonged to large companies in the private sector.

Using the Vessel DSCSI for non-SIDS, we found that high-income non-SIDS had a high Vessel DSCSI of 4, while all other income groups had a low Vessel DSCSI of 1 or 2 (Figure 18). One of the most significant factors regarding vessel satisfaction noted by multiple respondents for non-SIDS was the lack of maintenance for an aging fleet. Other considerations were access to large enough vessels or appropriate equipment and crew on board for offshore and deep-water work. Other factors included the high cost of operation and inconsistent funding, as well as governments with a priority for exploitation, not for scientific exploration. However, respondents for some non-SIDS noted that they had expertise and appropriate vessels such that opinion regarding vessels widely varied across GeoAreas.

On average, respondents in non-SIDS were more satisfied with the vessels to which they had access than those in SIDS.

7.6 Potential Impact of Increased Vessel Access

What is the potential impact of increased access to vessels? (Q15)

Respondents were asked what impact increased access to vessels would have on their work on a five-point scale from no impact to transformative.

Overall, 66% of respondents for SIDS reported that increased access to vessels would have a high impact or be transformative for their work (Figure 19). Five respondents (7%), two from lower-middle-income SIDS and three from high-income SIDS, reported that there would be no impact on their work with increased access to vessels.

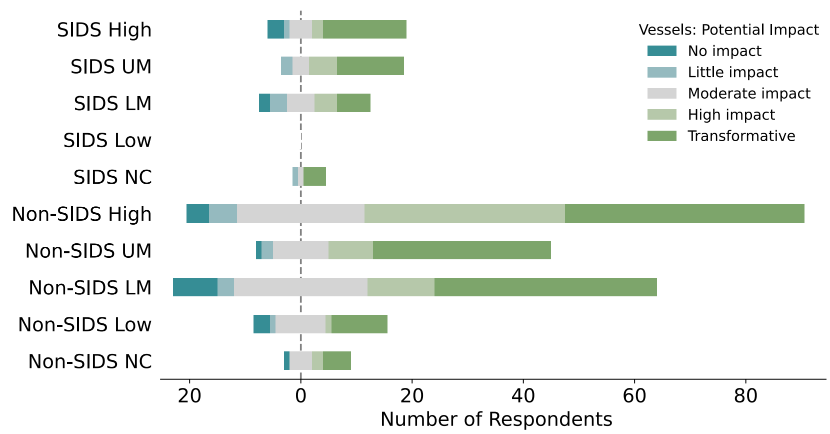


Figure 19
Vessels: Potential Impact
Number of respondents for each income group who said that increased access to vessels would have a high or transformative impact (green) or little to no impact (blue) on their work.

Two-thirds of respondents for non-SIDS also reported that increased access to vessels would have a high impact or be transformative for their work (Figure 19). Seventeen respondents (6%), distributed across income groups, reported that there would be no impact on their work with increased access to vessels.

"The Government has an excellent programme that allows junior researchers to join international research vessels conducting research in Barbados's waters. This has enabled capacity building in deep sea research and data collection"

– Respondent for Barbados, Caribbean

8. Deep Submergence Vehicles

8.1 Highlights

- **Importance** | Forty-four percent of respondents for SIDS and 70% of respondents for non-SIDS considered DSVs important for their work.
- **Presence** | Remotely Operated Vehicles (ROVs) were the most present DSVs in all SIDS combined, followed by benthic landers. Remotely operated vehicles (ROVs) were the most present DSVs in all non-SIDS combined, followed by autonomous underwater vehicles (AUVs).
- **Access** | ROVs were the most accessible DSV available in both SIDS and non-SIDS, but accessibility varied by income group. Nearly two-thirds of respondents for SIDS and 39% of respondents for non-SIDS did not have access to DSVs.
- **Depth Rating** | Across SIDS, only 31% of the 51 DSVs accessible to respondents for which depth rating was reported could operate deeper than 200 mbsl. Sixty-eight percent of the 519 DSVs to which respondents for non-SIDS had access could operate deeper than 200 mbsl.
- **Satisfaction** | Nearly two-thirds of respondents for SIDS and 42% of respondents for non-SIDS were dissatisfied with DSVs available in their GeoArea.
- **Potential Impact** | Fifty-eight percent of respondents for SIDS and 75% of respondents for non-SIDS reported that increased access to DSVs would significantly impact or be transformative for their work.

8.2 DSV Importance

How important are deep submergence vehicles (DSVs) for your work? (Q17)

Respondents were asked how important DSVs were for their work on a five-point scale from not important to very important.

Overall, 44% of respondents for SIDS considered DSVs important or very important for their work (Figure 20). Most respondents for high-income and not-categorized SIDS considered DSVs important for their work (50-56%). Eighteen respondents for SIDS (25%) considered DSVs not important for their work.

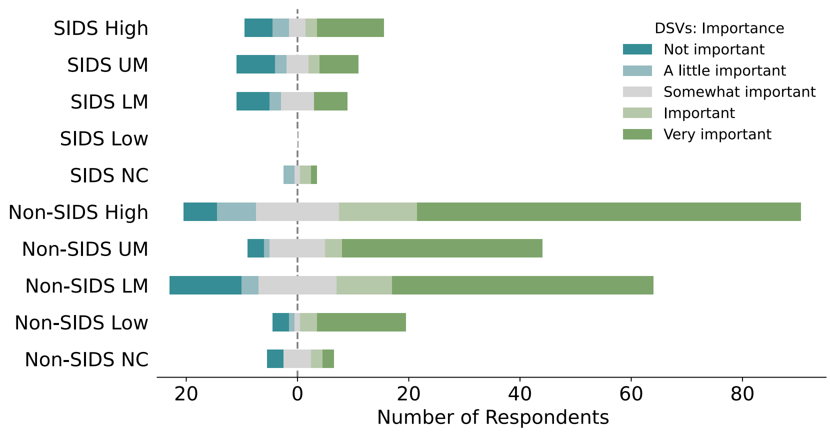


Figure 20
DSVs: Importance
Number of survey respondents for each income group who considered DSVs very important or important (green) to little or not important (blue) for their work.

For non-SIDS, 70% of respondents considered DSVs important or very important for their work (Figure 20). Ten percent of respondents for non-SIDS considered DSVs not important for their work across all income groups.

8.3 DSV Presence: Research Results

What types of DSVs are present in each GeoArea? (Q18R)

We researched the types of DSVs present in each GeoArea, specifically if the GeoArea had remotely operated vehicles (ROVs), autonomous underwater vehicles (AUVs), human-occupied vehicles (HOVs), benthic landers, drifters, or towsleds. We recorded the presence or absence of each type of DSV, with presence meaning that at least one vehicle of a given type was present in the GeoArea.

ROVs were the most common DSV type found across SIDS income groups, present in 19 SIDS (34%) (Figure 21A). High-income SIDS had the highest presence of benthic landers (present in 48% of GeoAreas) while also having a high presence of ROVs (43%), HOVs (38%), and AUVs (29%). Benthic landers were the second-most common type of DSV found across SIDS (27%). Towsleds were the least common, found in three SIDS (5%). No DSVs were found in low-income SIDS.

Across non-SIDS income groups, ROVs were the most common DSV type found, present in 73 GeoAreas (59%) (Figure 21A). While ROVs were the most present in most non-SIDS income groups, the percentage varied greatly across income groups, ranging from ROV presence in 14% of low-income non-SIDS to 81% of upper-middle and high-income non-SIDS. Benthic landers were the most present in not-categorized non-SIDS. AUVs were the second-most common across income groups, found in 43 non-SIDS (35%). Towsleds were the least common, found only in 20% of non-SIDS. Low-income GeoAreas had the fewest types of DSVs among non-SIDS.

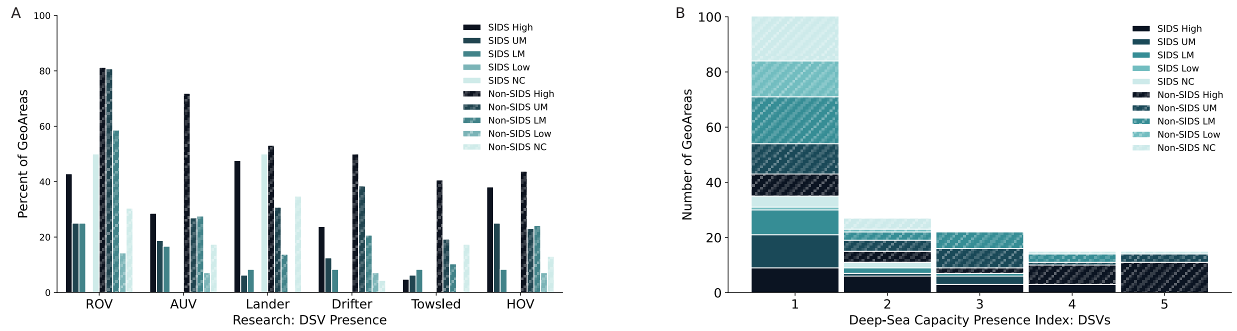


Figure 21
DSVs: Presence
(A) Percent of GeoAreas in each income group in which each type of DSV was found through research: remotely operated vehicles (ROV), autonomous underwater vehicles (AUV), benthic landers (Lander), drifters, towsleds, and human-occupied vehicles (HOV). **(B)** Number of SIDS and non-SIDS GeoAreas with each DSV Deep-Sea Capacity Presence Index. High DSV DSCPIs indicate higher diversity of DSV types present in each GeoArea.

The DSV Deep-Sea Capacity Presence Index (DSV DSCPI) assessed the research-based presence of types of DSVs in each GeoArea; higher values indicate higher diversity of DSV types present in each GeoArea.

We found that 35 SIDS (63%) had the minimum DSV DSCPI of 1 (i.e., few types of DSVs were present), and none had the maximum DSV DSCPI of 5 (Figure 21B). High-income SIDS had the highest DSV diversity per GeoArea, with three (14%) of the 21 high-income SIDS having a high DSV DSCPI of 4. Upper-middle, lower-middle, and low-income SIDS had the lowest DSV diversity with the largest percentage of GeoAreas with a DSV DSCPI of 1.

Using the DSV DSCPI, we found that high-income non-SIDS had a moderate average DSV DSCPI of 3. All other income groups had a low DSV DSCPI of 1 or 2. There were no low-income non-SIDS with a high DSV DSCPI of 4 or 5. Individually, 66 non-SIDS GeoAreas (53%) had the minimum DSV DSCPI of 1, and 15 (12%), primarily high-income non-SIDS, had the maximum DSV DSCPI of 5 (Figure 21B). High-income non-SIDS had the highest DSV diversity per GeoArea, with 18 GeoAreas (56%) having a DSV DSCPI of 4 or 5.

DSVs were the technical capacity with the lowest presence worldwide. The presence of DSV types in non-SIDS was found to be higher than in SIDS.

8.4 DSV Access: Survey Results

What kinds of DSVs do you have access to for deep-sea work? (Q18)

Respondents were asked to select all types of DSVs to which they had access for deep-sea work from a list of the following options: remotely operated vehicles (ROVs), autonomous underwater vehicles (AUVs), human-occupied vehicles (HOVs), benthic landers, drifters, towsled, or none of the above; they were also allowed to enter free-text if a type of DSV to which they had access was not an option.

The most accessible DSVs in SIDS were ROVs (available to 22% of respondents), followed by benthic landers (16%). Forty-six respondents for SIDS (63%) reported having no access to DSVs (Figure 22A). In each SIDS income group, except not-categorized SIDS, respondents had the most access to ROVs (18-32% of respondents). Access rates varied by income group, however. In not-categorized SIDS, the only accessible DSV type was the benthic lander. Within upper-middle, lower-middle, and not-categorized SIDS, more than half of the respondents reported no access to DSVs (60%-83%).

The most accessible DSVs in non-SIDS were ROVs, available to 45% of respondents, followed by AUVs (28%). One hundred thirteen respondents for non-SIDS (39%) reported having no access to DSVs (Figure 22A). Respondents had the most access to ROVs in each income group, although availability varied greatly among groups: 8% of respondents for not-categorized non-SIDS, to 75% for high-income non-SIDS. More respondents in low-income, lower-middle-income, and not-categorized non-SIDS had no access to DSVs than respondents who had access to any type of DSV in those income groups. Respondents for low and lower-middle-income non-SIDS had the least access to DSVs.

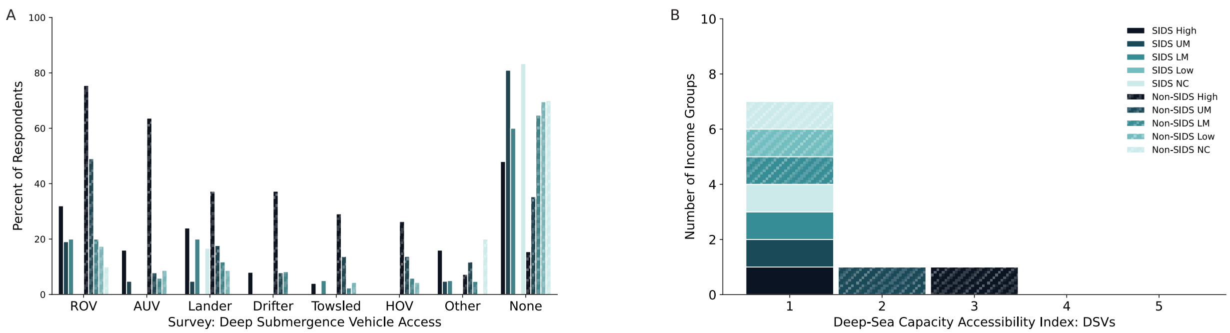


Figure 22
DSVs: Access
(A) Percent of respondents for each income group with access to each type of DSV: remotely operated vehicles (ROV), autonomous underwater vehicles (AUV), benthic landers (Lander), drifters, towsleds, and human-occupied vehicles (HOV), other, and none of the above. **(B)** Number of income groups worldwide with each DSV Deep-Sea Capacity Accessibility Index. High DSV DSCAIs indicate higher respondent-reported access to DSVs in their GeoArea.

The DSV Deep Sea Capacity Accessibility Index (DSV DSCAI) assessed the respondent-reported access to different types of DSVs in each subregion; higher values indicate higher access to more types of DSVs.

From the DSV DSCAI for SIDS, we found that all income groups had the lowest DSV DSCAI of 1, meaning that most respondents had little or no access to most types of DSVs (Figure 22B).

For non-SIDS, we found that high-income non-SIDS had a moderate DSV DSCAI of 3, and upper-middle-income non-SIDS had a low DSV DSCAI of 2 (Figure 22B). All other non-SIDS had a very low DSV DSCAI of 1.

While DSVs were the technical capacity to which respondents for both SIDS and non-SIDS had the lowest access worldwide, access to DSVs was higher for non-SIDS than for SIDS.

What is the approximate depth range of DSVs in your GeoArea? (Q19)

Respondents were asked to select the approximate depth range of the DSVs to which they had access from a list of the following options: 0-200 m, 0-1,000 m, 0-2,000 m, 0-4,000 m, >4,000 m, or not applicable.

Respondents for SIDS reported on the depth capabilities of 51 vehicles (only 9% of all reported depth DSVs in SIDS), 16 (31%) of which could operate in waters deeper than 200 mbsl (Figure 23A).

Respondents for non-SIDS reported on the depth capabilities of 550 vehicles (90% of all reported DSVs), 353 of which (68%) could operate in waters deeper than 200 mbsl (Figure 23A).

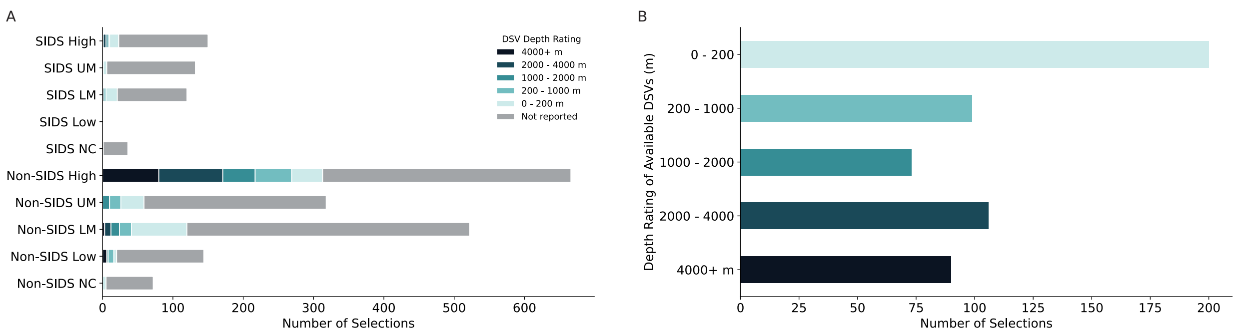


Figure 23
DSVs: Depth Rating
Number of deep submergence vehicles to which respondents reported access, shown by (A) income group and (B) depth zone. Selection counts include all types of DSVs to which respondents reported access: ROVS, AUVs, landers, drifters, towsleds, and HOVs.

In each SIDS income group, less than half of reported vehicles can go deeper than 200 mbsl. High-income SIDS had the most vehicles that can go deeper than 200 mbsl (43%); for the other groups, the rate was between 0% in not-categorized SIDS and 24% in lower-middle-income SIDS. Only one DSV, a benthic lander reported for high-income SIDS Puerto Rico, could operate deeper than 4,000 mbsl.

Respondents for high-income non-SIDS reported the most vehicles that can operate deeper than 200 mbsl (86% of all non-SIDs-reported DSVs), including the 24% of reported DSVs that can operate deeper than 4,000 mbsl. Overall, 32% of the DSVs accessible to respondents for all income groups across non-SIDS could not operate deeper than 200 mbsl.

8.5 DSV Satisfaction

How well do the DSVs meet your needs? (Q20)

Respondents were asked how satisfied they were with DSVs in their GeoArea in terms of cost, availability, *capabilities, depth rating, and duration, each on a five-point scale from very dissatisfied to very satisfied. Out of 73 total respondents for SIDS, 23-25 answered these questions (32-34% response rate). Out of 287 total respondents for non-SIDS, 169-176 answered these questions (32-34% response rate).*

Respondents for SIDS worldwide were generally dissatisfied with DSVs available to them (Figure 24). Overall, satisfaction was low for all aspects of satisfaction, varying between 13% for depth and 26% for capabilities (Figure 24E, D). Respondents for SIDS were the most dissatisfied with the availability of DSVs (72% dissatisfied) (Figure 24C).

Respondents for non-SIDS were divided in opinion on DSV operations (Figure 24). They were the most dissatisfied with availability (49%) and the least dissatisfied with operating depth (36%) of the DSVs to which they had access (Figure 24C, E). Respondents were the most satisfied with DSV duration and capabilities (44 and 42% satisfied, respectively) (Figure 24, F, C).

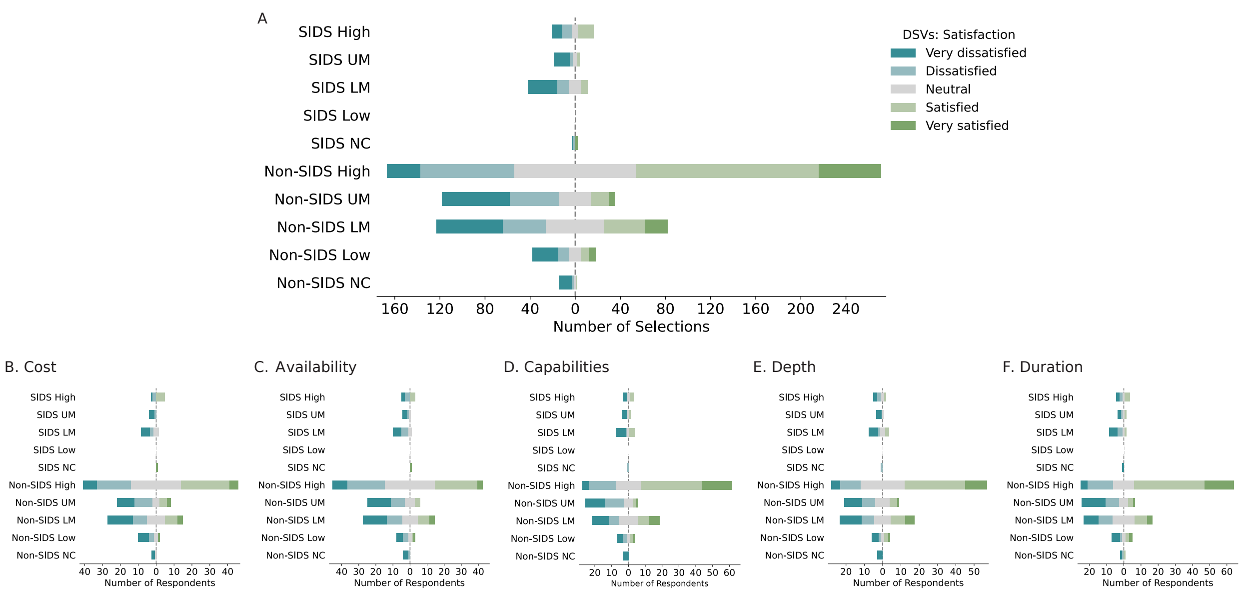


Figure 24
DSVs: Satisfaction
Number of respondents for each income group who are satisfied (green) or dissatisfied (blue) with all aspects of DSVs available to them in their GeoArea **(A)**. Number of respondents for each income group who are satisfied (green) to dissatisfied (blue) with each of the aspects of DSV operation: Cost **(B)**, Availability **(C)**, Capabilities **(D)**, Depth rating **(E)**, and Duration **(F)**.

Respondents for high-income SIDS were the least dissatisfied; 49% of respondents were dissatisfied with DSVs in their GeoArea, while 38% were satisfied. Respondents for upper-middle-income SIDS were the most dissatisfied; 74% of respondents for SIDS were dissatisfied with DSVs in their GeoArea. In not-categorized SIDS, respondents were more divided in opinion on DSVs. Respondents for lower-middle-income SIDS were also generally not satisfied; 70% expressed dissatisfaction with DSVs available to them (Figure 24).

Respondents for high-income non-SIDS were the least dissatisfied: 26% of respondents for high-income non-SIDS were dissatisfied with DSVs in their GeoArea, while 50% were satisfied. Respondents for not-categorized and upper-middle-income non-SIDS were the most dissatisfied with DSVs in their GeoArea (88 and 68%, respectively) (Figure 24).

The DSV Deep Sea Capacity Satisfaction Index (DSV DSCSI) assessed the respondent-reported satisfaction of DSVs based on several factors, including cost, DSV, and capabilities in each subregion; higher values indicate more overall satisfaction with DSVs to which respondents had access.

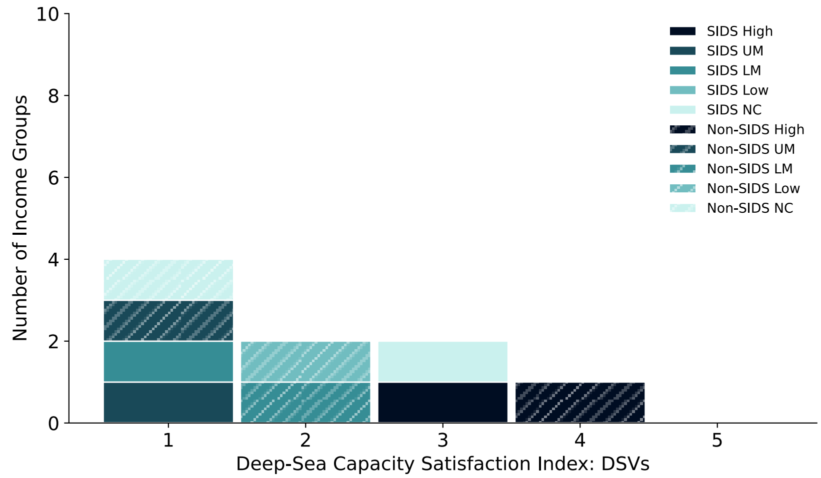


Figure 25
DSVs: Satisfaction
Number of income groups worldwide with each DSV Deep-Sea Capacity Satisfaction Index. High DSV DSCSIs indicate high respondent-reported satisfaction with the DSVs to which they have access.

From the DSV DSCSI for SIDS, we found that most respondents were not satisfied with DSVs (Figure 25). High-income and not-categorized SIDS had the highest DSV DSCSI, a moderate 3 out of 5. Upper-middle and lower-middle-income SIDS had the lowest DSV DSCSI of 1. Even so, DSVs were the technical capacity with which respondents expressed the highest satisfaction. Factors that respondents noted had an impact on how well DSVs in their GeoArea met their needs included the low availability of DSVs because the ones present in their GeoArea were for oil and gas prospecting. Many respondents highlighted that their GeoArea had trained personnel to operate DSVs, but the access was limited and restricted to the private sector.

Among non-SIDS, high-income GeoAreas had the highest satisfaction rate with a DSV DSCSI of 4. The lowest DSV DSCSI of 1 was found for upper-middle-income and not-categorized non-SIDS. DSVs were the technical capacity with which respondents for non-SIDS expressed the least satisfaction after Data Tools. Factors that respondents noted had an impact on how well DSVs in their GeoAreas met their needs included the cost, the low or inconsistent access to DSVs, low availability of trained personnel and expertise to operate and maintain them, and a lack of vessels required to operate DSVs as they are mainly used for defense or exploitation. A few participants also mentioned restrictions due to international conflicts.

Respondents in non-SIDS had a wider range of satisfaction levels for DSVs than SIDS, but respondents for both were dissatisfied with DSVs on average.

8.6 Potential Impact of Increased Access to DSVs

What is the potential impact of increased access to DSVs in your GeoArea? (Q21)

Respondents were asked what impact increased access to DSVs would have on their work on a five-point scale from no impact to transformative.

Across SIDS, 58% of respondents reported that increased access to DSVs would have a high impact or be transformative for their work (Figure 26). Responses were consistent towards high or transformative impact across SIDS (59%-68%), except for lower-middle-income SIDS, where only 40% of respondents reported that increased access to DSVs would have a strong impact on their work.

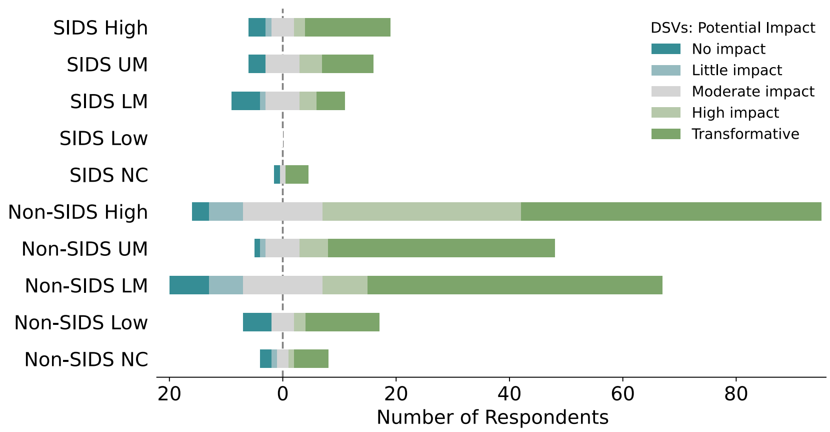


Figure 26
DSVs: Potential Impact
Number of respondents for each income group who said that increased access to DSVs would have a high or transformative impact (green) or little to no impact (blue) on their work.

Across non-SIDS, 75% of respondents reported that increased access to DSVs would have a high impact or be transformative for their work (Figure 26). Upper-middle-income non-SIDS had the highest fraction of responses suggesting increased access would have a high or transformative impact (85%). A minority in each income group responded that increased access to DSVs would have little or no impact (4%-25%).

> "Tonga is one of those countries that gives license for exploration in its EEZ. So for all we know from the contracting company, they can give any erroneous data and we have no way of validating them. Tonga would benefit from an ROV."
>
> – Respondent for Tonga, Polynesia

9. Sensor Systems

9.1 Highlights

- **Importance** | Sixty-seven percent of respondents for SIDS and 76% of respondents for non-SIDS considered deep-sea sensing systems important for their work.
- **Presence** | Water sampling and navigation systems were the most common type of sensors found across both SIDS and non-SIDS. In SIDS, imaging, mapping, eDNA, and chemical sensor systems were the least common; in non-SIDS, eDNA sensors were the least present.
- **Access** | Water sampling and chemical sensor systems were the most common type of sensors found across SIDS. Water sampling and CTD systems were the most accessible type of sensors found across non-SIDS. More than half the respondents for SIDS and 18% of the respondents for non-SIDS reported having no access to deep-sea sensors.
- **Satisfaction** | Respondents for SIDS were generally split in opinion on deep-sea sensors in their GeoArea. Respondents for non-SIDS were moderately satisfied with sensor systems.
- **Potential Impact**| More than two-thirds of respondents for SIDS and nearly 75% of respondents for non-SIDS reported that increased access to deep-sea sensor systems would have a high impact or would be transformative for their work.

9.2 Sensor System Importance

How important are deep-sea sensors for your work? (Q23)

Respondents were asked how important deep-sea sensors were for their work on a five-point scale from not important to very important.

Globally, 52% of respondents for SIDS considered deep-sea sensing systems important to very important for their work (Figure 27). Except in lower-middle-income SIDS, the majority of respondents for each income group considered deep-sea sensors important to very important for their work. Nine respondents (14%) considered deep-sea sensors not important for their work.

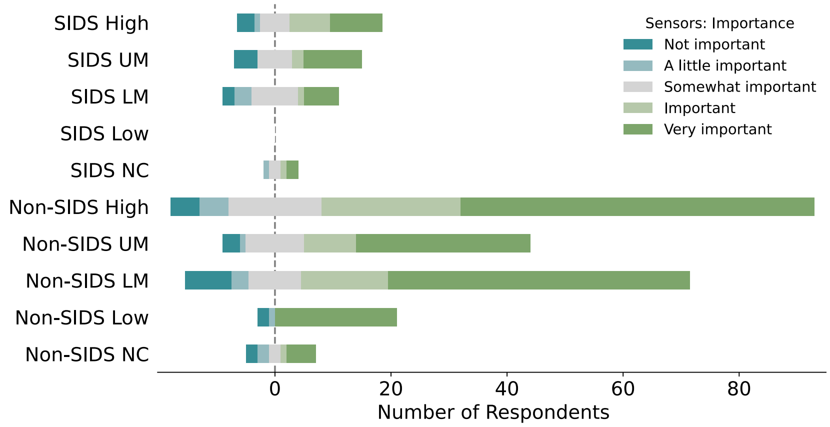


Figure 27
Sensors: Importance
Number of survey respondents for each income group who considered sensors very important or important (green) to little or not important (blue) for their work.

On average, 76% of respondents for non-SIDS consider deep-sea sensing systems important to very important for their work (Figure 27). The majority of respondents for non-SIDS across all income groups considered deep-sea sensors important to very important for their work. Twenty respondents (7%) for non-SIDS considered deep-sea sensors not important for their work.

9.3 Sensor System Presence: Research Results

What types of deep-sea sensor systems are present in each GeoArea? (Q24R)

We researched the types of sensor systems present in each GeoArea, specifically if the GeoArea had CTDs, chemical sensors (e.g. O_2, pH, eH), water sampling systems, navigation systems, seafloor mapping systems, or imaging systems. We recorded the presence or absence of each type of sensor system, with presence meaning that at least one sensor system of a given type was present in the GeoArea.

Water sampling systems were the most common sensor systems found within SIDS, present in 54% of SIDS, followed by navigation systems (present in 50%) (Figure 28A). Environmental DNA (eDNA) systems were the least common, found in only 24% of SIDS.

The most common sensors across non-SIDS were water sampling and navigation systems (each present in 62% of GeoAreas) (Figure 28A). Environmental DNA (eDNA) systems were the least common, found in 38% of non-SIDS.

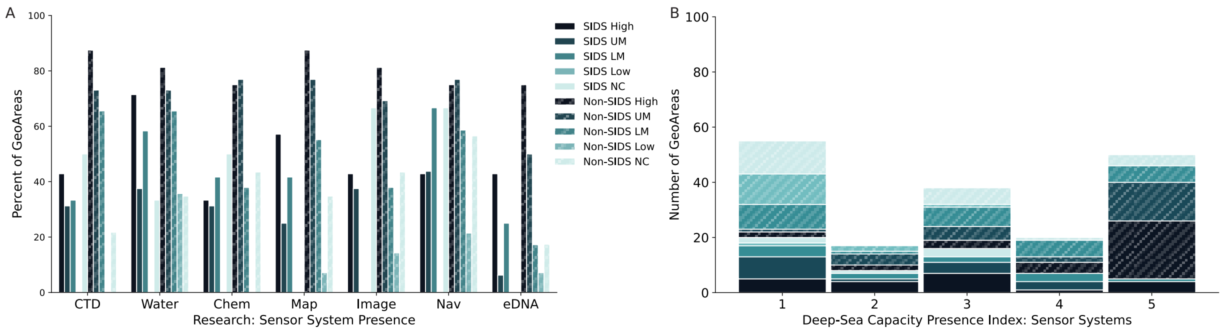


Figure 28
Sensors: Presence
(A) Percent of GeoAreas in each income group in which each type of sensor system was found through research: CTDs, water sampling systems (Water), chemical sensors (Chem), seafloor mapping systems (Map), imaging systems (Image), navigation systems (Nav), and environmental DNA sensors (eDNA). **(B)** Number of SIDS and non-SIDS GeoAreas with each Sensor Deep-Sea Capacity Presence Index. High Sensor DSCPIs indicate higher diversity of sensor types present in each GeoArea.

The Sensor Deep-Sea Capacity Presence Index (Sensor DSCPI) assessed the research-based presence of types of sensors in each GeoArea; higher values indicate higher diversity of sensor types present in each GeoArea.

Using the Sensor DSCPI, we found that all SIDS income groups had a low to moderate diversity of sensors (Figure 28B). Low-income SIDS had the lowest Sensor DSCPI of 1, while high and lower-middle-income SIDS had a moderate Sensor DSCPI of 3, the highest among SIDS. The average Sensor DSCPI for SIDS was lower than that for non-SIDS GeoAreas. Five SIDS (9%) had the maximum Sensor DSCPI of 5 (i.e., many types of sensor systems were present), and 20 SIDS (36%) had the minimum Sensor DSCPI of 1. High-income SIDS had four of the five Sensor DSCPIs of 5, yet 43% of the 21 high-income SIDS had a Sensor DSCPI of 1 or 2. Therefore, it followed lower-middle-income SIDS, which had the highest diversity of sensor systems present with 33% of DSCPI of 4 or 5. Upper-middle-income SIDS had the lowest diversity of sensor systems present, with the largest percentage of SIDS with a Sensor DSCPI of 1 (50%) or 2 (6%) and zero SIDS with a Sensor DSCPI of 5.

For non-SIDS, we found that the diversity of sensors varied among income groups: low-income and not-categorized non-SIDS had the low Sensor DSCPIs of 1 and 2, while high and upper-middle-income non-SIDS had the high Sensor DSCPI of 4 (Figure 28B). The average Sensor DSCPI for non-SIDS was higher than the average Sensor DSCPI for SIDS. Sixteen GeoAreas (13%) had the maximum Sensor DSCPI of 5 (i.e., many types of sensor systems were present), and 52 GeoAreas (42%) had the minimum Sensor DSCPI of 1. High-income non-SIDS had the highest diversity of sensor systems present, with 40% of GeoAreas with DSCPIs of 4 or 5.

Sensors were a technical capacity that had limited and inconsistent presence worldwide.

9.4 Sensor System Access: Survey Results

What kinds of deep-sea sensors do you have access to for deep-sea work? (Q24)

Respondents were asked to select all types of sensor systems to which they had access for deep-sea work from a list of the following options: CTDs, chemical sensors (e.g., O_2, pH, eH), imaging systems, water sampling, navigation, seafloor mapping, or none of the above; they were also allowed to enter free-text if a type of sensor system to which they had access was not an option.

Among SIDS, the most accessible sensor systems were water sampling systems (available to 33% of respondents for SIDS), followed by chemical sensors (e.g., O_2, pH, eH) (available to 30% of respondents). More than half the respondents for SIDS (52%) reported having no access to deep-sea sensors (Figure 29A). Sensor accessibility varied greatly across SIDS income groups. In high-income and not-categorized SIDS, respondents had the most access to imaging systems (17-20%), while respondents for upper and lower-middle-income SIDS had the most access to water sampling systems (45%). Except in the lower-middle-income group, 45-68% of all other SIDS income groups reported having no access to deep-sea sensors. The eDNA sensor was the least accessible sensor across all income groups (0-9%).

For non-SIDS, the most accessible sensor systems were CTDs (available to 66% of respondents for non-SIDS), followed by water sampling systems (available to 63% of respondents). Eighteen percent of the respondents reported having no access to deep-sea sensors, mostly in low-income and not-categorized non-SIDS (Figure 29A). The most accessible sensor systems varied for different non-SIDS income groups: high and upper-middle-income non-SIDS had the most access to CTDs, lower-middle-income and not-categorized non-SIDS to water sampling systems, and low-income non-SIDS had the most access to chemical sensors for oxygen and pH sensors. However, a majority of respondents in both low-income (46%) and not-categorized (58%) non-SIDS had no access to sensors in their GeoArea. Environmental DNA sensors were the least accessible sensor for all income groups, except for low-income non-SIDS where navigation systems were the least accessible.

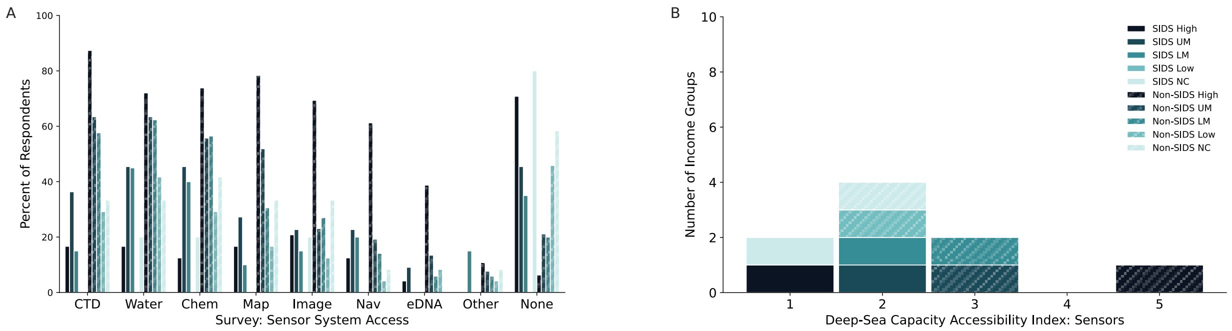


Figure 29
Sensors: Access
(A) Percent of respondents for each income group with access to each type of sensor system: CTDs, water sampling systems (Water), chemical sensors (Chem), seafloor mapping systems (Map), imaging systems (Image), navigation systems (Nav), and environmental DNA sensors (eDNA), other, and none of the above. **(B)** Number of income groups with each Sensor Deep-Sea Capacity Accessibility Index. High Sensor DSCAIs indicate higher respondent-reported access to sensor systems in their GeoArea.

The Sensor Deep Sea Capacity Accessibility Index (Sensor DSCAI) assessed the respondent-reported access to different types of sensors in each subregion; higher values indicate higher access to more types of sensors.

From the Sensor DSCAI for SIDS (Figure 29B), we found access to a variety of sensors is generally low and similar across SIDS income groups, with Sensor DSCAIs of 1 or 2. For SIDS, sensor systems were the technical capacity to which respondents had the second-lowest level of access after DSVs. Sensor systems were the technical capacity to which respondents for non-SIDS had the highest level of access after data analysis tools.

For non-SIDS, we found that access to a variety of sensors ranged from low for the low-income and not-categorized non-SIDS (Sensor DSCAI of 2) to very high for high-income non-SIDS (Sensor DSCAI of 5) (Figure 29B).

Access to sensor systems was higher in non-SIDS than in SIDS.

9.5 Sensor System Satisfaction

How well do deep-sea sensors meet your needs? (Q25)

Respondents were asked how satisfied they were with deep-sea sensor systems in their GeoArea in terms of cost, availability, capabilities, depth rating, ease of use, and accuracy, each on a five-point scale from very dissatisfied to very satisfied. Out of 73 total respondents for SIDS, 27-29 answered these questions (37-40% response rate). Out of 287 total respondents for non-SIDS, 214-226 answered these questions (75-79% response rate).

Across SIDS, 40% of respondents were dissatisfied or very dissatisfied with deep-sea sensors in their GeoArea (Figure 30A). Overall, respondents were the most satisfied with sensor system depth and generally split in opinion on accuracy, capability, and availability (Figure 30C, D, G). They were the least satisfied with sensor system cost (Figure 30B).

Across non-SIDS, 47% of respondents were satisfied or very satisfied with deep-sea sensors in their GeoArea (Figure 30A). Overall, 47-57% of respondents were satisfied or very satisfied with sensor system accuracy, capabilities, depth rating, and ease of use (Figure 30D-G). They were split in opinion on cost and availability (Figure 30B, C).

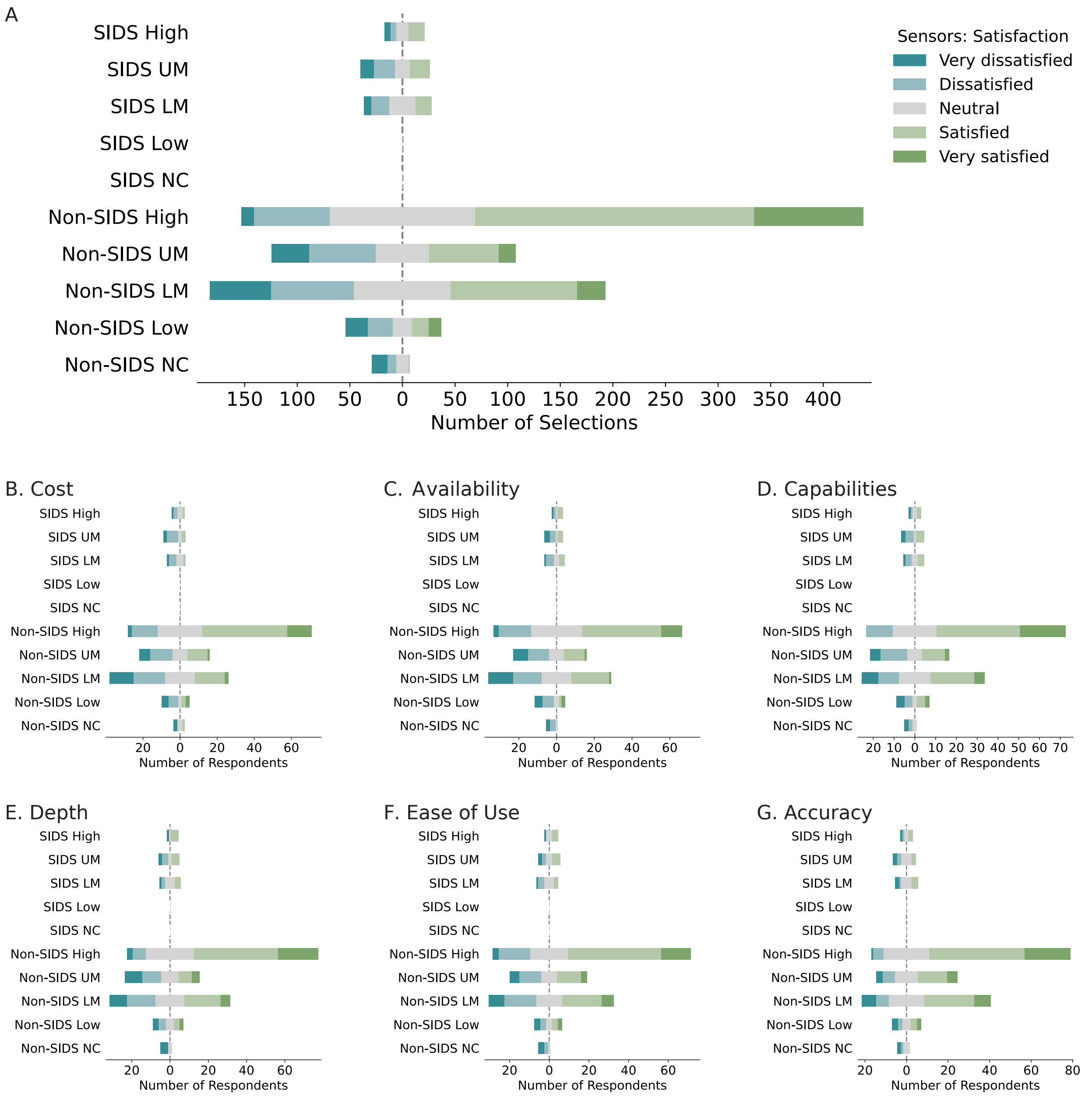


Figure 30
Sensors: Satisfaction

Number of respondents for each income group who are satisfied (green) or dissatisfied (blue) with all aspects of sensors available to them in their GeoArea **(A)**. Number of respondents for each income group who are satisfied (green) to dissatisfied (blue) with each of the aspects of sensor operation: Cost **(B)**, Availability **(C)**, Capabilities **(D)**, Depth rating **(E)**, Ease of Use **(F)**, and Accuracy **(G)**.

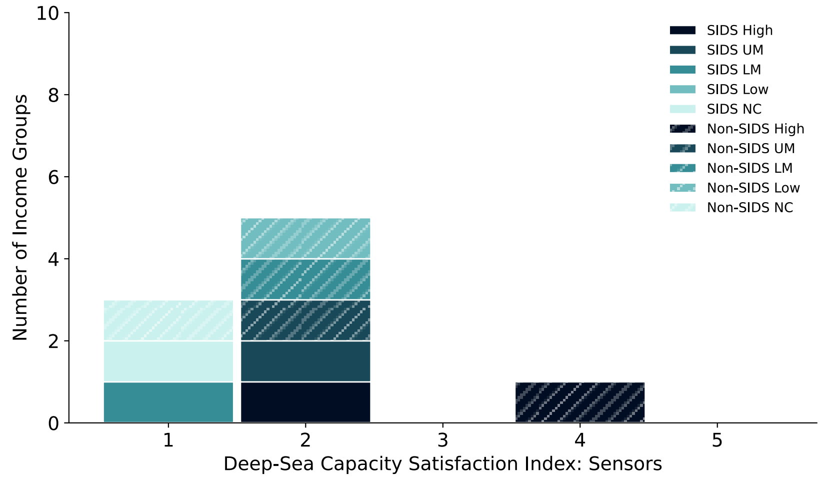


Figure 31
Sensors: Satisfaction
Number of income groups worldwide with each Sensor Deep-Sea Capacity Satisfaction Index. High Sensor DSCSIs indicate high respondent-reported satisfaction with the sensor systems to which they have access.

The Sensor Deep Sea Capacity Satisfaction Index (Sensor DSCSI) assessed the respondent-reported satisfaction of sensors based on several factors, including cost, availability, and capabilities in each subregion; higher values indicate more overall satisfaction with sensors to which respondents had access.

From the Sensor DSCSI for SIDS (Figure 31), we found that the level of satisfaction with sensor systems was generally low. Respondents for lower-middle-income and not-categorized SIDS were the least satisfied with the sensor systems to which they had access (Sensor DSCSI of 1). The highest Sensor DSCSI was observed for high and upper-middle-income SIDS but was only 2 out of 5. Sensors were the technical capacity with the lowest satisfaction in SIDS. Factors respondents for SIDS noted that impacted how well deep-sea sensors met their needs included instrument maintenance, repair, and maintenance training.

For non-SIDS, we found that the level of satisfaction with sensor systems was generally low (Sensor DSCSIs of 1 or 2) except in high-income non-SIDS where the overall Sensor DSCSI was 4 (Figure 31). Factors respondents noted that impacted how well deep-sea sensors in their GeoArea met their needs included funding and technical considerations such as access to calibration, acquisition and import of parts, aging instruments because of limited instrument maintenance and repair. Other factors included the lack of technical expertise and training, deployment capacities (e.g., limitation to shallow waters), internal bureaucracy, and customs taxes on imports.

On average, respondents in non-SIDS were more satisfied with the sensor systems to which they had access than those in SIDS.

9.6 Potential Impact of Increased Access to Sensors

What is the potential impact of increased access to deep-sea sensors? (Q26)
Respondents were asked what impact increased access to deep-sea sensors would have on their work on a five-point scale from no impact to transformative.

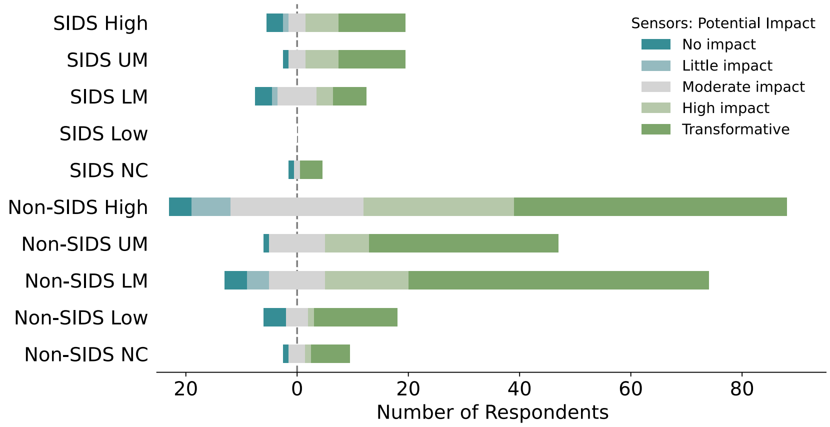
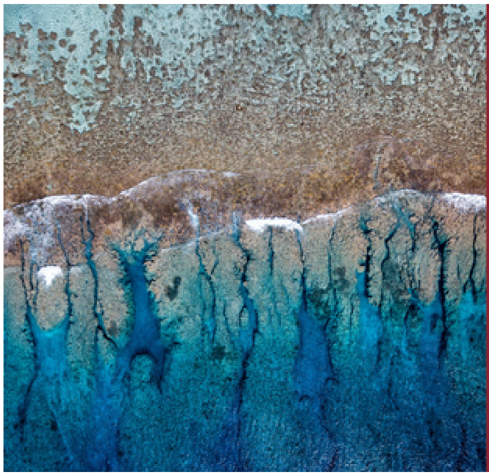


Figure 32
Sensors: Potential Impact
Number of respondents for each income group who said that increased access to sensor systems would have a high or transformative impact (green) or little to no impact (blue) on their work.

Across SIDS, 67% of respondents reported that increased access to deep-sea sensor systems would have a high impact or be transformative for their work (Figure 32). Less than half the respondents (47%) for lower-middle-income SIDS reported that increased access would result in high/transformative impact, while it was 67-82% of respondents for the other SIDS income groups. Eight respondents across SIDS (14%) reported there would be no impact on their work with increased access to deep-sea sensor systems.

Across non-SIDS, 74% of the respondents reported that increased access to deep-sea sensor systems would have a high impact or be transformative for their work (Figure 32). The number of responses for high impact or transformative was consistently high across all non-SIDS income groups. Fourteen respondents across non-SIDS (9%) reported that there would be no impact on their work with increased access to deep-sea sensor systems.



"We have basic bathymetry estimates for Palau's EEZ, but require multi beam sonar and backscatter data to provide info on habitats, provide a baseline of current habitats and enable us to identify important conservation areas and areas to focus future exploration on."

– Respondent for Palau, Micronesia

10. Data Tools

10.1 Highlights

- **Importance** | Eighty-five percent of respondents for SIDS and 88% of respondents for non-SIDS considered data analysis & access tools important for their work.
- **Presence** | Geographic information systems (GIS) were the most common type of data tools found in both SIDS and non-SIDS. ML/AI systems were the least common in SIDS and genomic sequencing tools were the least commonly found in non-SIDS.
- **Access** | GIS was the most accessible type of data tool in both SIDS and non-SIDS. Only 15% of the respondents for SIDS and 20% of the respondents for non-SIDS reported having no access to the listed data tools.
- **Satisfaction** | Respondents for SIDS were split in opinion on data tools across all income groups. Less than half of respondents for non-SIDS were satisfied with the data tools to which they had access.
- **Potential Impact** | More than two-thirds of respondents for SIDS and 77% of respondents for non-SIDS reported that increased access to deep-sea sensor systems would have a high impact or would be transformative for their work.

10.2 Data Tools Importance

How important are data analysis & access tools for your work? (Q28)

Respondents were asked how important data tools were for their work on a five-point scale from not important to very important.

On average, 85% of respondents for SIDS consider data tools important or very important for their work (Figure 33). Consistently across SIDS, the majority of respondents considered data tools important to very important for their work. Two respondents, both from lower-middle-income SIDS, considered data tools not important for their work.

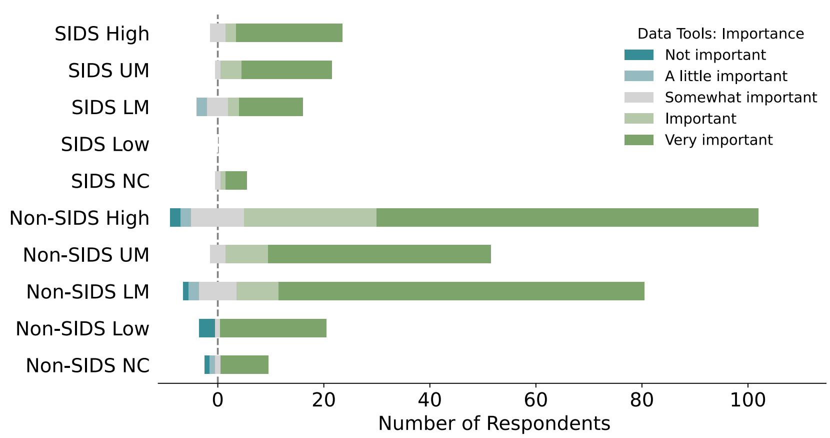


Figure 33
Data Tools: Importance
Number of survey respondents for each income group who considered data tools very important or important (green) to little or not important (blue) for their work.

On average, 88% of respondents for non-SIDS consider data tools important to very important for their work (Figure 33). Consistently across non-SIDS income groups, the majority of respondents considered data tools important to very important for their work. Seven respondents for non-SIDS considered data tools not important for their work, representing 2% of the respondents across non-SIDS GeoAreas.

10.3 Data Tools Presence: Research Results

What type of data analysis & access tools are present in each GeoArea? (Q29R)

We researched the types of data tools present in each GeoArea, specifically if the GeoArea had geographic information systems (GIS), data management tools, data storage capacity, data visualization tools, machine learning/artificial intelligence (ML/AI), cloud computing, and/or genomic sequencing tools. We recorded the presence or absence of each type of data tool, with presence meaning that at least one data tool of a given type was present in the GeoArea.

In SIDS, the most present data tool was GIS, found in 82% of SIDS, followed by data management tools and genomic sequencing tools (Figure 34A). ML/AI systems were the least present, found in 23% of SIDS.

In non-SIDS, the most present data tool was GIS, found in 91% of GeoAreas, followed by cloud computing and ML/AI (each found in 77% of non-SIDS GeoAreas) (Figure 34A). Genomic sequencing was the least present but still found in 65% of all non-SIDS.

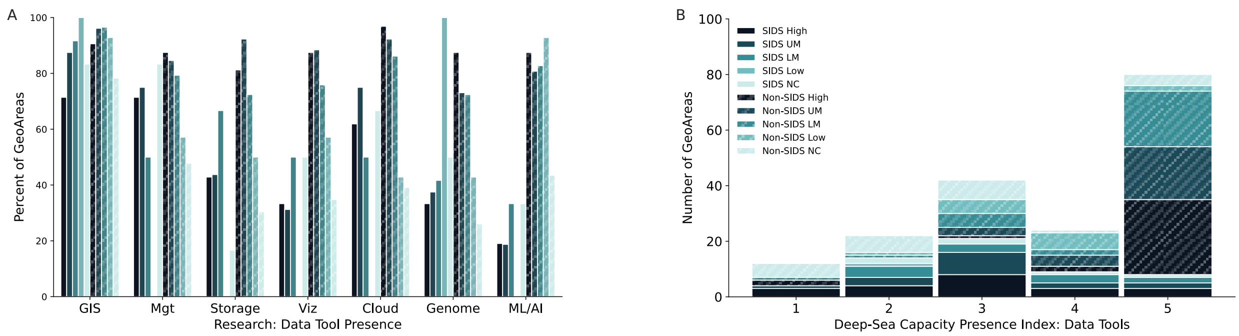


Figure 34
Data Tools: Presence
(A) Percent of GeoAreas in each income group in which each type of data tool was found through research: GIS, data management tools (Mgt), data storage tools (Storage), data visualization tools (Viz), cloud computing (Cloud), genomic sequencing (Genome), and machine learning/artificial intelligence (ML/AI). **(B)** Number of SIDS and non-SIDS GeoAreas with each Data Deep-Sea Capacity Presence Index. High Data DSCPIs indicate higher diversity of data tool types present in each GeoArea.

The Data Deep-Sea Capacity Presence Index (Data DSCPI) assessed the research-based presence of types of data tools in each GeoArea; higher values indicate higher diversity of data tool types present in each GeoArea.

Using the Data DSCPI, we found that all SIDS income groups had a moderate average Data DSCPI of 3, except low-income SIDS, which had a low average Data DSCPI of 2 (Figure 34B). Eight SIDS (14%) had the maximum Data DSCPI of 5 (i.e., many types of data tool systems were present), and four SIDS (7%) had the minimum Data DSCPI of 1. In all SIDS income groups, presence varied greatly: there were similar proportions of GeoAreas with high Data DSCPI of 4 or 5 (26-42%) and low Data DSCPI of 1 or 2 within each income group. Lower-middle-income SIDS had the highest diversity of data tool systems present, with 42% of Data DSCPIs of 4 or 5. Upper-middle-income SIDS had the lowest percentage of GeoAreas with a Data DSCPI of 5 (13%).

For non-SIDS, we found that high and upper-middle-income non-SIDS had a very high average Data DSCPI of 5, while low-income non-SIDS had a moderate average Data DSCPI of 3 (Figure 34B). Sixteen non-SIDS (12%) had a low Sensor DSCPI of 1 or 2 (i.e., only few types of data tool systems were present) and seventy-two non-SIDS (52%) had the highest Sensor DSCPI of 5. The presence of data tools varied greatly among income groups: the highest diversity of data tool systems was present in high-income non-SIDS with 84% of DSCPI of 5. The low-income and not-categorized non-SIDS had the lowest percentage of GeoAreas with a Sensor DSCPI of 4 or 5 and not-categorized non-SIDS also had the highest with a Sensor DSCPI of 1 or 2 (48%).

Data tools were the second most present technical capacity in non-SIDS after vessels. The average DSCPI of non-SIDS was higher than that for SIDS.

10.4 Data Tools Access: Survey Results

What kinds of data analysis & access tools do you have access to? (Q29)

Respondents were asked to select all types of data tools to which they had access for deep-sea work from a list of the following options: cloud computing, data management tools, data storage capacity, data visualization tools, genomic sequencing, geographic information systems (GIS), machine learning/artificial intelligence (ML/AI), or none of the above; they were also allowed to enter free-text if a type of data tool to which they had access was not an option.

Across SIDS, the most accessible data tools were consistently GIS tools, available to 81% of respondents, while genome sequencing and ML/AI systems were consistently the least accessible, available to 7% of respondents for SIDS (Figure 35A). Fifteen percent of the respondents for SIDS reported having no access to the listed data tools.

For non-SIDS, the most accessible data tools were consistently GIS tools, available to 76% of respondents, while ML/AI systems and genome sequencing were consistently the least accessible, available to 25-28% of respondents for non-SIDS (Figure 35A). Fifty-eight respondents for non-SIDS (20%) reported having no access to the listed data tools, mostly in low-income non-SIDS.

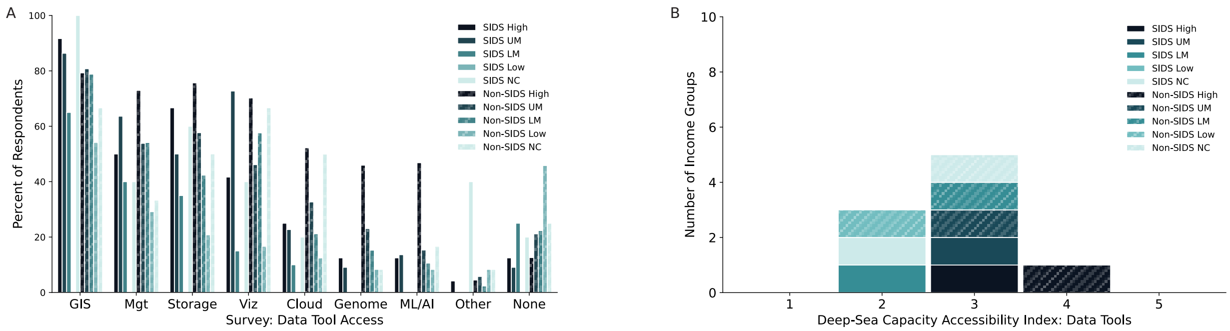


Figure 35
Data Tools: Access
(A) Percent of respondents for each income group with access to each type of data tool: GIS, data management tools (Mgt), data storage tools (Storage), data visualization tools (Viz), cloud computing (Cloud), genomic sequencing (Genome), machine learning/artificial intelligence (ML/AI), other, and none of the above. **(B)** Number of income groups with each Data Deep-Sea Capacity Accessibility Index. High Data DSCAIs indicate higher respondent-reported access to data tools in their GeoArea.

The Data Deep Sea Capacity Accessibility Index (Data DSCAI) assessed the respondent-reported access to different types of data tools in each subregion; higher values indicate higher access to more types of data tools.

From the Data DSCAI for SIDS, we found that access to data tools was low to moderate (Figure 35B). Lower-middle and not-categorized SIDS had a low Data DSCAI of 2, while high and upper-middle-income SIDS had a moderate Data DSCAI of 3. While data tools were the technical capacity to which respondents had the highest access in SIDS, the average accessibility to data tools across SIDS was still lower than for non-SIDS.

For non-SIDS, high-income GeoAreas had a high Data DSCAI of 4, while low-income non-SIDS had a low Data DSCAI of 2. All other income groups had a moderate Data DSCAI of 3. Data tools were the technical capacity to which respondents had the second-highest access in non-SIDS, after sensors.

Globally, data tools were the most accessible technical capacity. Respondents for non-SIDS had more access to data tools than respondents for SIDS.

10.5 Data Tools Satisfaction

How well do data analysis & access tools meet your needs? (Q30)

Respondents were asked how satisfied they were with data tools in their GeoArea in terms of cost, availability, capabilities, ease of use, and bandwidth, each on a five-point scale from very dissatisfied to very satisfied. Out of 73 respondents for SIDS, 57-60 answered these questions (78-82% response rate). Out of 287 respondents for non-SIDS, 243-248 answered these questions (85-86% response rate).

In general, respondents of SIDS were split in opinion on data tools but were generally most satisfied with their capabilities (44% of respondents satisfied or very satisfied) and ease of use (43%) (Figure 36A, D, E). They were least satisfied with their cost and bandwidth (46% dissatisfied or very dissatisfied) (Figure 36B, F).

Respondents for non-SIDS were split in opinion on their satisfaction with data tools (Figure 36A). Respondents for high-income non-SIDS were generally satisfied, respondents for not-categorized non-SIDS were dissatisfied, and there was a wide range of responses for all other income groups. Overall, respondents were generally more satisfied with data tools capabilities and bandwidth in their GeoArea and less so for the cost (Figure 36B, D, F).

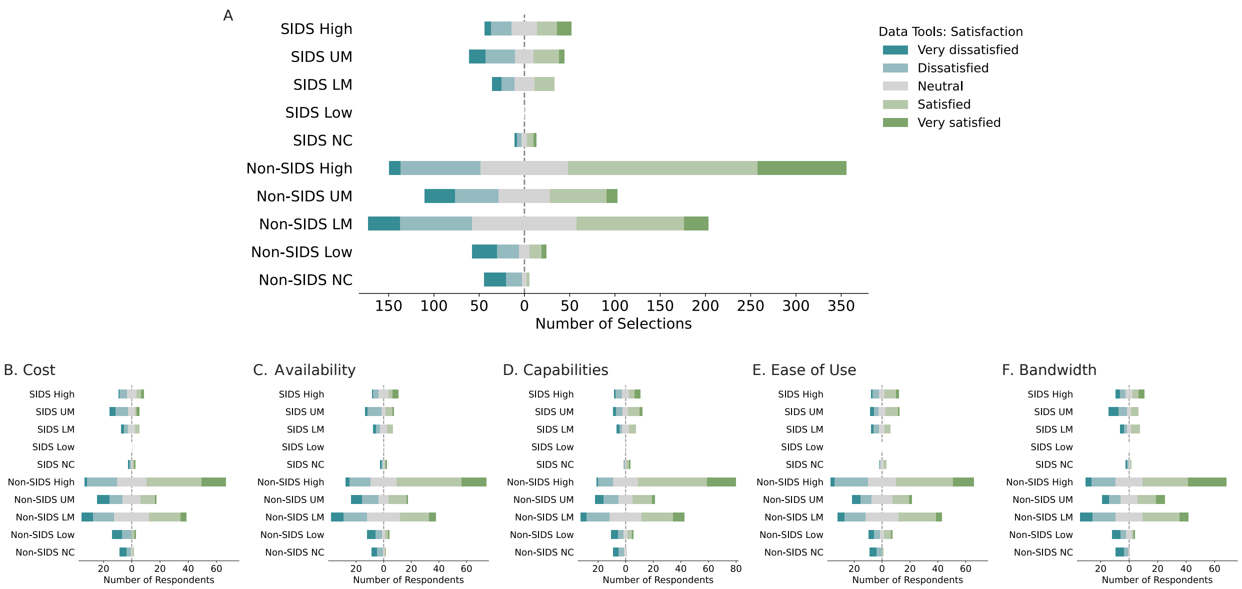


Figure 36
Data Tools: Satisfaction

Number of respondents for each income group who are satisfied (green) or dissatisfied (blue) with all aspects of data tools available to them in their GeoArea **(A)**. Number of respondents for each income group who are satisfied (green) to dissatisfied (blue) with each of the aspects of data tool operation: Cost **(B)**, Availability **(C)**, Capabilities **(D)**, Ease of Use **(E)**, and Bandwidth **(F)**.

The Data Deep Sea Capacity Satisfaction Index (Data DSCSI) assessed the respondent-reported satisfaction with data tools based on several factors, Data cost, availability, and capabilities in each subregion; higher values indicate more overall satisfaction with data tools to which respondents had access.

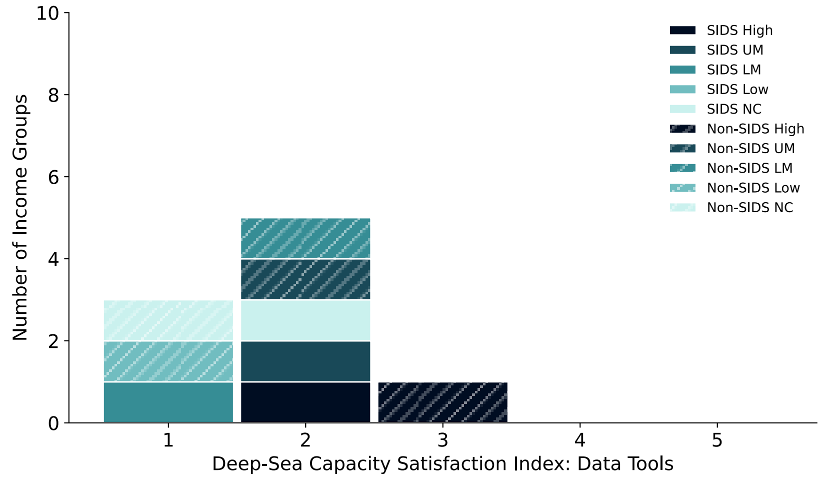


Figure 37
Data Tools: Satisfaction
Number of income groups with each Data Deep-Sea Capacity Satisfaction Index. High Data DSCSIs indicate high respondent-reported satisfaction with the data tools to which they have access.

From the Data DSCSI for SIDS, we found that Data DSCSI was generally low (Figure 37). Lower-middle-income SIDS had the lowest Data DSCSI of 1, while all other groups had a Data DSCSI of 2. While presence and access to data tools were generally high, respondents of SIDS were the second-least satisfied with these tools after sensors. Respondents for multiple locations noted that unstable and unreliable internet availability with low speed and a high cost was a significant factor that affected their data tool use. Respondents from multiple GeoAreas reported issues with the management of data, notably its cost and the fact data is managed abroad rather than at the national level. They also noted that it would require technical training to support the collection and use of data.

For non-SIDS, we found that Data DSCSI was generally low across non-SIDS, with the highest satisfaction in high-income non-SIDS (Data DSCSI of 4) and the lowest in not-categorized non-SIDS (Data DSCSI of 1) (Figure 37). All other income groups had a low Data DSCSI of 2. Respondents for multiple non-SIDS noted that the lack of training and access to data was a significant factor that affected their data tool use. Respondents also reported on the need for more data sharing, coordinated data management, best practice guidelines, and infrastructure for increased archiving and management, such as cloud computing.

On average, respondents in non-SIDS were more satisfied with the data tools to which they had access than those in SIDS.

10.6 Potential Impact of Increased Access to Data Tools

What is the potential impact of increased access to data analysis & access tools in your GeoArea? (Q31)
Respondents were asked what impact increased access to data tools would have on their work on a five-point scale from no impact to transformative.

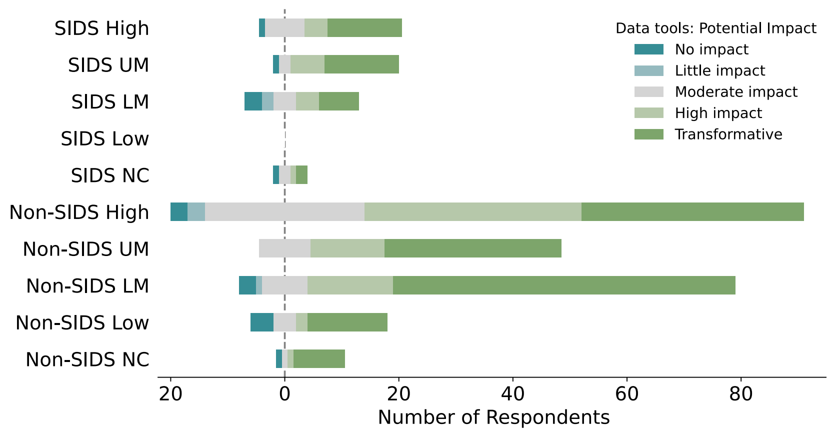


Figure 38
Data Tools: Potential Impact
Number of respondents for each income group who said that increased access to data tools would have a high or transformative impact (green) or little to no impact (blue) on their work.

Across SIDS, 68% of respondents reported that increased access to data tools would have a high impact or be transformative for their work (Figure 38). Positive responses range from 50% in not-categorized SIDS to 86% of the respondents for upper-middle-income SIDS. Yet, six respondents for SIDS (8%) reported there would be no impact on their work with increased access to data tools.

Among non-SIDS, 77% of respondents reported that increased access to data tools would have a high impact or be transformative for their work (Figure 38). The potential impact of increased access to data tools in non-SIDS was reported to be consistently high, ranging from 67% in low-income non-SIDS to 86% in lower-middle-income non-SIDS. Eleven respondents across non-SIDS (4%) reported there would be no impact on their work with increased access to data tools.

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