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Article title: Enabling interdisciplinary research capacity for sustainable development: Self- evaluation of the Blue Communities project in the UK and Southeast Asia
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Preprint statement: This article is a preprint and has not been peer-reviewed, under consideration and submitted to UCL Open: Environment Preprint for open peer review.
Links to data: Culhane, Fiona E. and Cheung, Victoria and Austen, Melanie (2022). Self-reported Change in Research Capacity Following Participation in an Interdisciplinary Research Project, 2017-2021. [Data Collection]. Colchester, Essex: UK Data Service. 10.5255/UKDA-SN-856101
Funder(s): UKRI
DOI: 10.14324/111.444/000189.v2
Preprint first posted online: 09 November 2023
Keywords: interdisciplinary, transdisciplinary, marine and coastal ecosystems, research culture, environmental sustainability, Environmental science, Sustainability

Title

Enabling interdisciplinary research capacity for sustainable development: Self- evaluation of the Blue Communities project in the UK and Southeast Asia

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Abstract

Global challenges such as climate change, food security and human health and wellbeing disproportionately impact people from low-income countries. These challenges are complex and require an international and transdisciplinary approach to research, with research skills and expertise from different disciplines, sectors, and regions. In addressing this, a key goal of the research project, Blue Communities, was to create and expand mutual interdisciplinary capacity of both United Kingdom and Southeast Asian Partners. An existing questionnaire on research capacity was uniquely adapted to include interdisciplinary and international aspects and distributed for the first time as an online survey to the participants of the Blue Communities project comprising researchers across all career stages. Participants were asked about their perceptions of the research capacity and culture of their organisation, team and self and whether they believed any aspects have changed since involvement with the project. Greatest improvement was seen at the self level where results indicated a positive relationship between an individual's current success or skill and their improvement over the course of the research project across 18 out of 22 aspects of research capacity for Southeast Asian, and 2 for UK respondents. The conflict between achieving research aims, building research capacity and making societal impact was evident. Institutional support is required to value these core aspects of interdisciplinary research.

25 Keywords: interdisciplinary, transdisciplinary, marine and coastal ecosystems, research culture,

26 environmental sustainability

27

1. Introduction

Global challenges such as climate change, food security and human health and wellbeing disproportionately impact people from low-income countries (IPCC, 2018) and are addressed through global governance with the United Nations Sustainable Development Goals (UN, 2015, Biermann et al., 2017). It is increasingly recognised in the research community, by research funders (e.g. the UK's Global Challenges Research Fund[1]) and by institutions (e.g. universities) that these challenges are complex and require an international and interdisciplinary approach to research, integrating research skills and expertise from different disciplines, sectors and regions (Fransman et al., 2021, Dangles et al., 2016). Building from a zero or near zero situation and/or strengthening existing sustainable capacity in research communities is required to address these global challenges (Fransman et al., 2021), and we use these terms interchangeably hereafter. With finance and research agendas dominated by the Global North (Barrett et al., 2011, Karlsson et al., 2007), research capacity is recognised to be unevenly distributed and often limited in the regions where global challenges are most felt (Harvey et al., 2022). Research programmes aimed at addressing global challenges therefore increasingly try to embed research capacity building and/or strengthening (Harvey et al., 2022). Capacity building must increase the resilience of the individual and/or organisation, thereby ensuring their longer-term sustainability (Woodhill, 2010) to address complex global challenges.

The often uneven coverage of global challenges research between high- and low-income countries is exemplified by ecosystem service research, a key link between ecosystems and human wellbeing, which is lacking in Southeast (SE) Asian countries (Hattam et al. (2021). Collaboration between high income countries (HIC) and low income countries (LIC) has been suggested as a way to increase

[1] The Global Challenges Research Fund (GCRF) is a UK fund that promotes achievement of the UN Sustainable Development Goals in developing countries, through supporting international research. It is part of the UK's Official Development Assistance (ODA) programme that aims to promote sustainable growth of OECD (Organisation for Economic Cooperation and Development) selected developing countries. https://royalsociety.org/~/media/grants/schemes/ODA-GCRF.pdf?la=en-GB&hash=B51F1E2140346184856E2F87D6F4B32A

research capacity across all partners and to fill such research gaps (Hammad and Al-Ani, 2021, UNEP, 2002). However, studies have shown that research capacity building in such collaborations can be limited, for example publications are often led by authors in HIC (Dangles et al., 2016, Harvey et al., 2022). Nevertheless, it should also be noted that outputs of research publications and research funding, driven largely by the funders and the research culture in HICs, are not the only indication of research capacity (Chu et al., 2014, Hewitson, 2015). Achieving these research products, can be in conflict with building research capacity (Barrett et al., 2011, Harvey et al., 2022). In addition, the UK perception of 'good' research may contrast with perceptions of those in other cultures (Hoang, 2021). Harvey et al. (2022) argue that significant disruption of the current system is required to truly achieve balanced research capacity.

The Blue Communities interdisciplinary research and capacity building project recognised that marine and coastal ecosystems are essential for food security, livelihoods, health and well-being through direct human activities such as fisheries and tourism, and for regulating and supporting services like climate regulation; and that global loss of biodiversity and ecosystem services should be addressed through an integrated approach (Cheung et al., 2021 https://www.plymouth.ac.uk/research/institutes/marine-institute/our-research/blue-communities). Blue Communities was a four-year project, funded by the UK's Global Challenges Research Fund (GCRF), that aimed to build capacity for sustainable interactions with marine ecosystems for health, well-being, food security and livelihoods. The primary objectives were to:

1. Develop collaborative interdisciplinary research to improve the integrated management of marine and coastal environments to reduce conflict between users, mitigate risks associated with expanded or new uses, and protect fragile ecosystems while supporting livelihoods, food security, health and well-being of coastal communities.
2. Create and expand mutual interdisciplinary capacity and capability building of both UK and SE Asian Partners and the study communities in integrated planning through sustainable

interactions with marine ecosystems for the health, well-being, food and livelihoods of coastal communities.

The GCRF sought to achieve '*meaningful and equitable relationships*' (Grieve and Mitchell, 2020) through the goal of building research capacity across partners involved in the projects they funded. In the Blue Communities project, *"a 'learn by doing' approach, where SE Asian researchers were encouraged to lead their research studies and seek support from experienced UK researchers when needed*" was taken (Blue Communities Handbook). Throughout the project, Blue Communities activities (e.g. skills workshops, paper writing, seminars, mentorship, flexible communication, networking, formation of research ethics and health and safety committees, etc.) allowed the building of research capacity, while achieving research objectives. The project also formed an Early Career Researcher network and encouraged Early Career Researchers to develop their own funding calls, proposals, and apply for additional funding that had been set aside from the original core budget to support these.

The success of this approach can be evaluated by looking at the research products, however, this will only capture the current research outputs and not the sustainable future research capacity that has been built through the project. By taking a broader perspective on research capacity from a diverse group of researchers and allowing researchers involved in the project to have an opportunity to formally reflect on and report their perceptions of how research capacity has improved through involvement with the project, we are able to gain a fuller understanding of research capacity within the group. This learning can be used to enhance or modify approaches used for capacity building in future collaborations.

The aims of this paper are to:

- evaluate the perceptions of the current research capacity of the organisations, research teams and individuals involved in the Blue Communities (BC) project and identify potential strengths and gaps
- evaluate the perceptions of the change in the research capacity of the organisations, research teams and individuals attributed to involvement in Blue Communities, and link this to the approach used by the Blue Communities (BC) research programme
- explore demographic factors, particularly region, that may influence these perceptions
- evaluate the successes and challenges and their implications for growing current and future research capacity for sustainable development

2. Methods

2.1 Questionnaire

The questionnaire was based on the Research Capacity and Culture Tool (Holden et al., 2012) that gathers information on participant's perceptions of the research capacity and culture of their institution, team and self across a range of generic research capacity markers. This questionnaire was adapted by the authors to be relevant to the researchers in this project. Specifically, additional markers for assessment were added, including on interdisciplinary and international working, carrying out research that has impact and a question about the effect of the COVID-19 pandemic. Further open and closed questions were added to gain more in-depth insight into the perspectives of the project participants and how these aligned with the overarching aims of the project and the work that was carried out during the project. The questionnaire was held on the JISC online platform and the link distributed by email to the members of the Blue Communities project. Project members

were mainly from academic institutions and non-governmental organisations in the UK and in four Southeast (SE) Asian countries – Malaysia, Philippines, Indonesia and Vietnam. Researchers within the project ranged from those with little research experience to those with long careers in research, and categories in the survey were chosen to capture all of these career stages. The survey was distributed in February 2022 and was open for two weeks. The timing of the distribution of the survey coincided with the final two months of the four-year Blue Communities grant and therefore captured perceptions at this point in time. The survey was written in the English language and consisted of questions in four parts: (1) demography, (2) individual research capacity, (3) team level research capacity (participant's Blue Communities team at their own institution) and (4) institution level research capacity. Questions included those with a numeric scale response to rate skills on various aspects related to research capacity and rating scale responses to assess change in research capacity. See Supplementary Material for full survey.

2.2 Data analysis

The demographic factor of main interest was the broad region of the respondent. To explore overall perceptions of research capacity and whether these differed between groups based on region (Global South and Global North), quantitative data were summarised based on the country of participant, or UK (/European) vs SE Asian. Other demographic variables (gender, age, career stage/research experience and contract type) were also explored for associations with different responses to perceptions of research capacity. Due to small cell sizes, Fishers exact test was used to explore associations between variables throughout, with p values reported and significance taken at the 0.05 level.

To compare across unequal groups of responses to questions on what activities people participated in, what resources they benefited from, what are their motivators and barriers to carrying out research, and what they valued most from the project, responses were weighted according to the total number of individuals per group. That is, the frequency of responses is shown as the proportion

of participants in a group who responded. These are presented as bar plots. Where response rates were low in certain groups, categories were combined as indicated (e.g. undergraduate plus MSc research experience).

The responses to a number of statements regarding participants' experience in the project is visualised in side-by-side matrix plots where the size and colour of squares represent the frequency of responses against each score to each aspect of research capacity for UK (and other European) and SE Asian respondents. Matrix plots were produced using Raw Graphs 2.0 (https://rawgraphs.io/).

The relationship between the current research capacity (current success or skill across a range of aspects) and perceived improvement in capacity of these, was explored through Spearman rank correlation for the UK (and other) and the SE Asian regions. Correlation plots, trend line, R and p values were produced using ggplot2 (Wickham, 2009) in R (R Development core Team, 2016). Significance was taken at the 0.05 level.

3. Results

3.1 Demographic information

A total of 56 people responded to the survey, out of approximately 115 researchers who were involved over various time periods throughout the project. Of these, most (57%) were female and aged between 31-50 (64%) (Table 1). The largest group of respondents came from the UK (or other European countries) and the smallest from Indonesia.

Table 1 Demographics of the Blue Community research community who responded to the online survey

Demographic variable	Category	Response Rate (%)	Number of individuals
Gender	*Female*	57	32
	Male	41	23
	Prefer not to say	2	1
Age range *	*18-30*	16	9
	31-50	64	36
	51+	18	10
	Prefer not to say	2	1
Country of Institution	*Indonesia*	7	4
	Malaysia	20	11
	Philippines	23	13
	UK (and other European)	33	18
	Vietnam	18	10

*Four age categories were recorded in the survey, but due to low response 51-64 and 65+ categories were merged

Most respondents to the survey came from academia (88%), though NGOs and government agencies were also represented (Table 2). Most researchers had fixed term contracts and multiple work commitments. All career stages from early, mid, and later career were represented in the survey, though most came from the broader early career categories (students and PhD + five years or less experience).

There was evidence of an association between age and gender ($p=0.01$), with more younger researchers being female; and age and experience ($p<0.01$), with older researchers having more experience (for full results see Table S1). There was also an association between experience and country ($p=0.01$) or region (i.e. UK and other vs SE Asia; $p=0.02$), with researchers with less experience being more likely to be from SE Asian countries.

Table 2 Information about the career type, stage and formal research experience of the Blue Community research community who responded to the online survey

Variable	Category	Response Rate (%)	Number of individuals
Sector	• *Academia*	88	49
	• *NGO*	9	5
	• *Other (Government Agency)*	4	2
Contract Type	• *Fixed Term*	55	31
	• *Permanent*	45	25
Research Experience*	• *Undergraduate degree and/or current MSC student*	14	8
	• *MSc and/or current PhD student*	25	14
	• *PhD with up to 5 years*	14	8
	• *More than 5-15 years post Phd*	29	16
	• *More than 15 years post PhD*	18	10
Type of Involvement in BC project	• I work only on the Blue Communities project or Blue Communities is my main research project.	27	15
	• My time is divided amongst multiple research projects, of which Blue Communities is one.	23	13
	• Blue Communities is my only research project, but I also have other work commitments such as teaching or administrative work.	9	5
	• My time is divided amongst multiple research projects, of which Blue Communities is one, and I also have other work commitments such as teaching or administrative work.	42	23

*Research experience had seven separate categories in the original survey, but due to low response rate in some groups Undergraduate degree was merged with current MSC student; and MSc was merged with current PhD student

3.2 Individual Research Capacity

Respondents took part in a broad range of activities throughout the project, with most people involved in publishing, presenting, analysing quantitative data, collecting data and designing studies (Figure 1). There was no evidence of an association with the type of activities carried out and gender ($p=0.987$), age ($p = 0.984$), experience ($p=1$), contract type ($p=0.998$) and country ($p=1$) or region ($p=0.811$) (see also Table S2). Most researchers were involved in particular with writing reports (86%) and publications (82%), collecting (61%) and analysing (61%) data, and designing studies (61%). Fewer people overall were involved with applying for and securing research funding (41%), submitting financial claims (32%), and submitting health and safety assessments (21%).

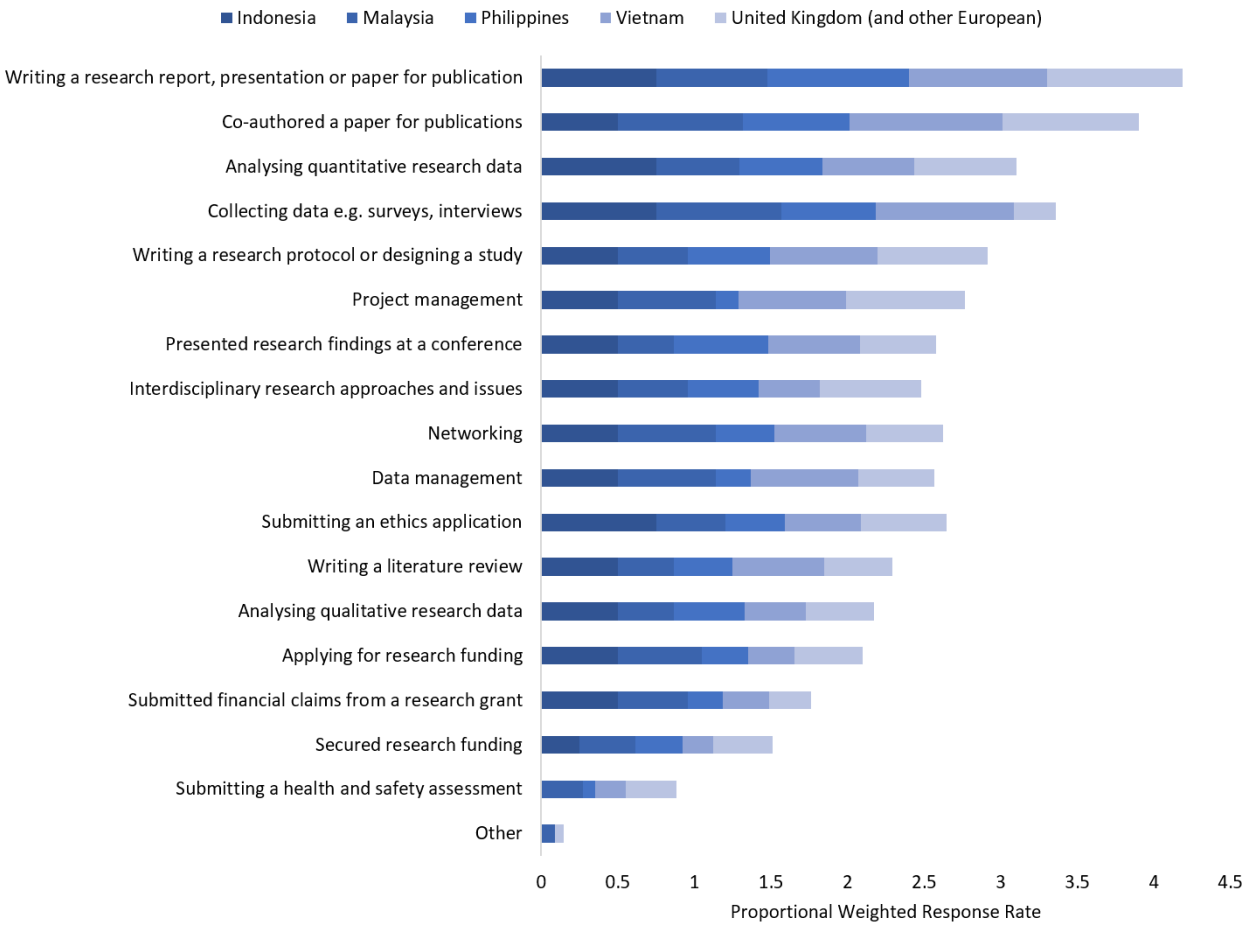


Figure 1 Research activities respondents have been involved with as part of the Blue Communities project. Respondents could choose as many options as were relevant. The bars are weighted according to the total number of respondents from each country/region (e.g. if every respondent chose an option, each bar segment would have a value of 1).

The resources researchers benefited from were associated with the region (p=0.002, Table S2). Respondents across all regions benefitted the most from knowledge exchange resources such as seminars (80%), networking (79%), training (79%), access to expertise (73%) and mentorship (70%) (Figure 2). Resources such as protocol development (38%), library access (34%), health and safety guidance (30%), database management (30%) and software (27%) benefitted fewer respondents overall, but of those, benefits were felt mostly by the SE Asian respondents.

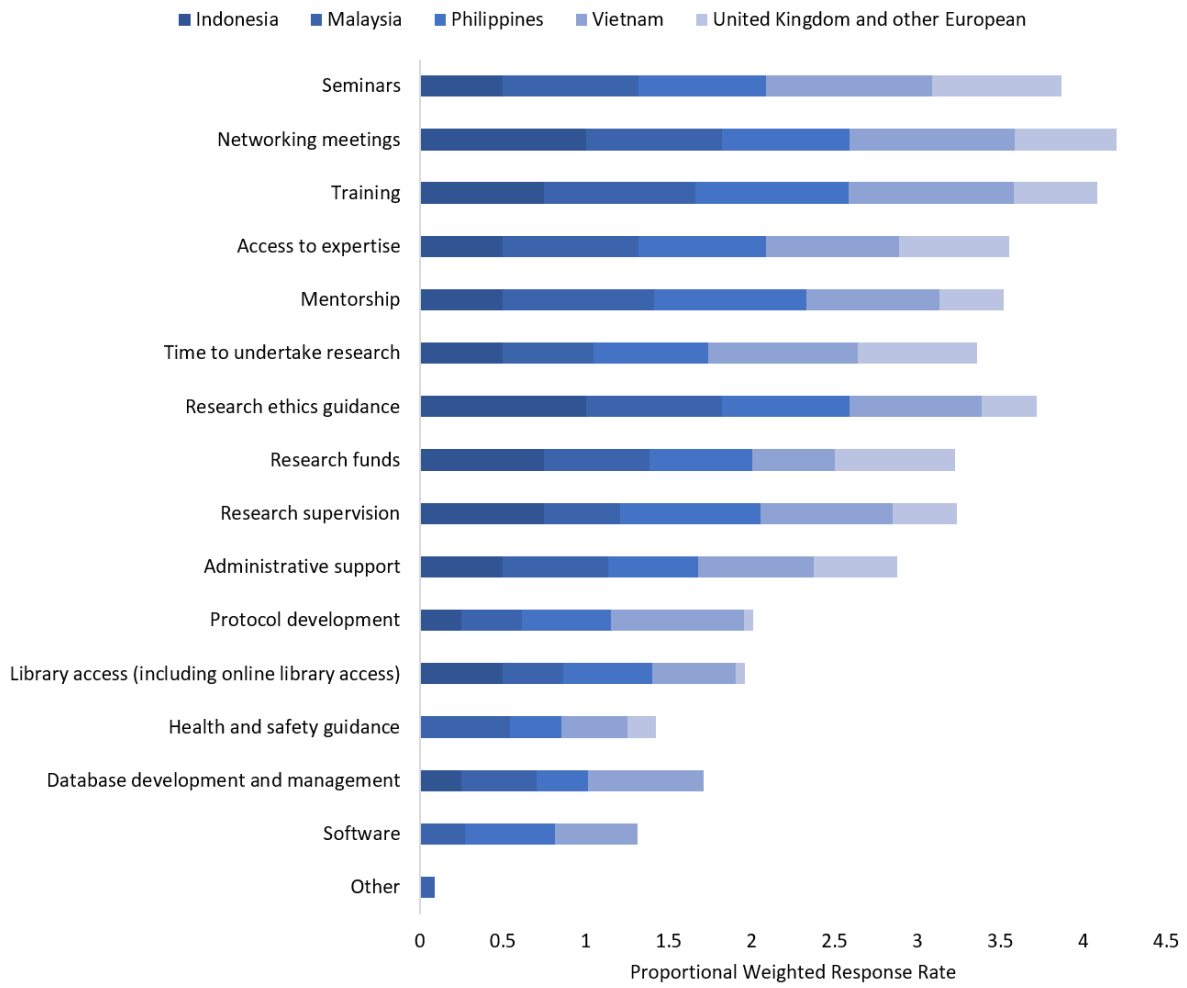
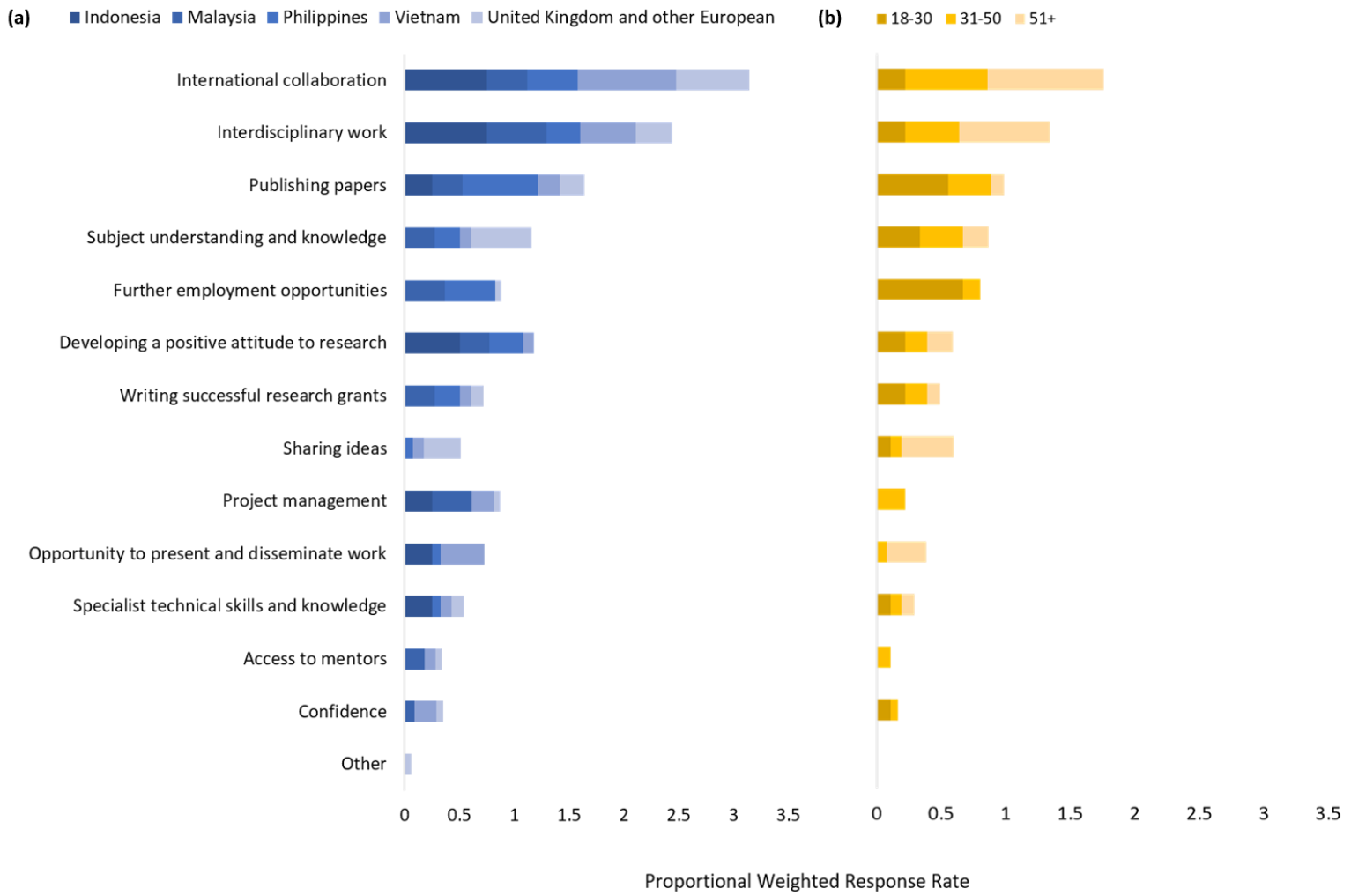


Figure 2 Resources respondents benefited from through the Blue Communities partnership. Respondents could choose as many options as were relevant. The bars are weighted according to the total number of respondents from each country/region (e.g. if every respondent chose an option, each bar segment would have a value of 1).

When asked what the respondents valued most from their Blue Communities experience, respondents across all across regions and career stages most valued interdisciplinary (61%) and international working (43%), publishing papers (34%) and improving their subject understanding and knowledge (30%) (Figure 3). There was evidence of an association between age and the skills and opportunities valued (p=0.023, Table S2); younger researchers in particular valued publishing papers and further employment opportunities. Country (p=0.030) and region (p=0.005) also had an association with values, with SE Asian researchers being more associated with valuing developing a positive attitude to research.



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233 **Figure 3** Research skills or opportunities respondents valued the most from their experience in Blue Communities. Respondents could choose up to three
234 options. The bars are weighted according to the total number of respondents from (a) each country/region, and (b) their age (e.g. if every respondent chose
235 an option, each bar segment would have a value of 1

Many of the top barriers to research that respondents identified were related to time constraints in general (e.g. 'Lack of time for research' (54%), 'Desire for work/life balance' (41%), 'Other work roles take priority' (38%) and 'Lack of suitable backfill' (38%)) (Figure 4). There was an association with the contract type (p=0.009, Table S2), with those on fixed term contracts particularly identifying lack of long term employment and personal motivations as barriers. COVID pandemic restrictions was also identified as a key barrier by 48% of respondents, particularly for SE Asian researchers (p=0.001). Other barriers were a lack of long-term employment (27%), personal commitments (23%), fear of getting it wrong (21%) and lack of skills (20%). English language was identified by 13% of respondents as being a barrier.

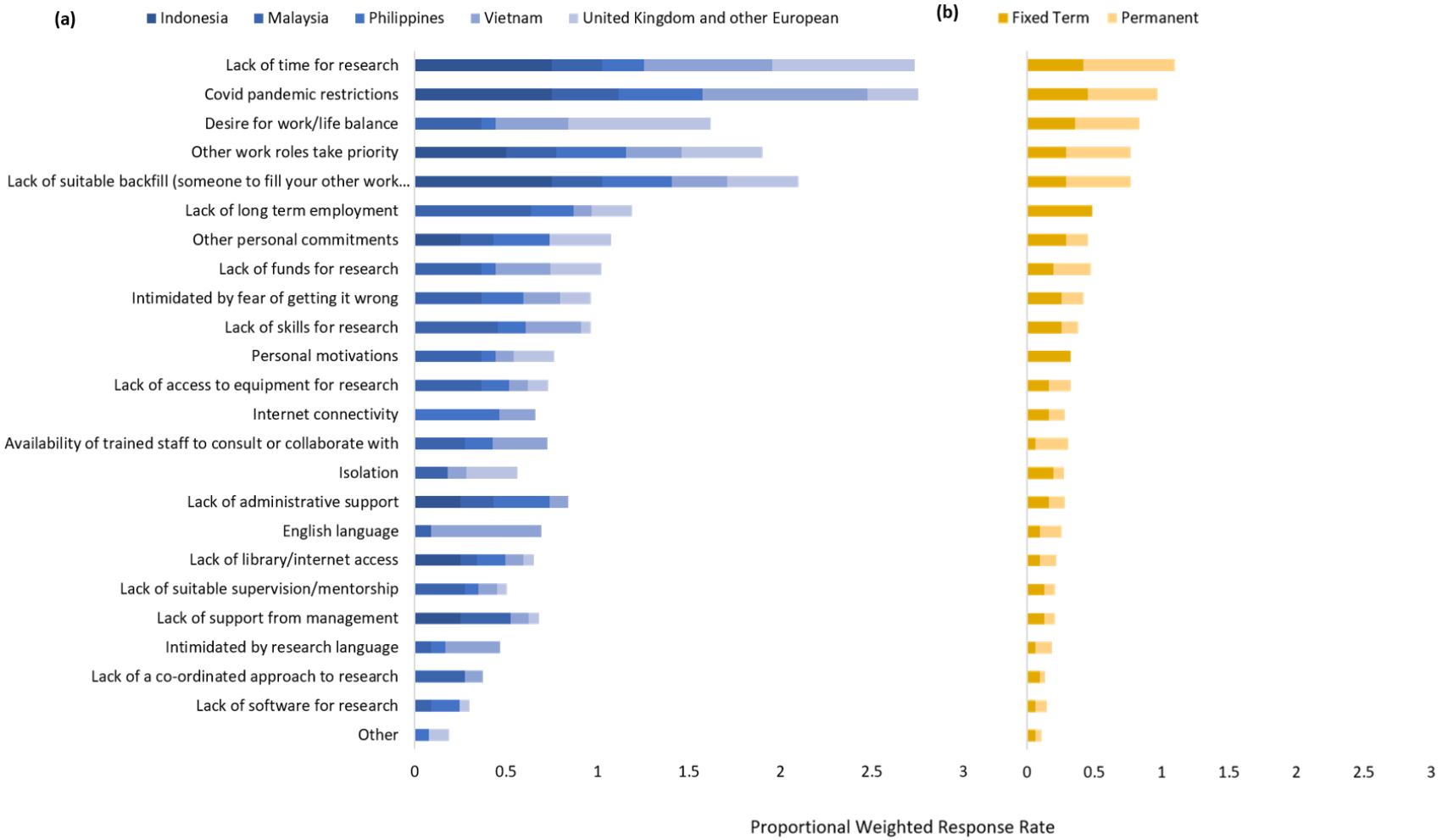

Figure 4 Barriers to research, according to participants of the Blue Communities project. Respondents could choose as many options as were relevant. The bars are weighted according to the total number of respondents from (a) each country/region, and (b) their contract type (e.g. if every respondent chose an option, each bar segment would have a value of 1).

When asked what personally motivates them to carry out research, respondents indicated developing skills (79%), advancing their career (64%), making an impact (a problem that needs solving) (61%), increased job satisfaction (54%) and science curiosity (46%) (Figure 5). These options were indicated across gender, age, contract type, regional and career stage groups showing the motivations for research were common across this group of researchers (Table S2).

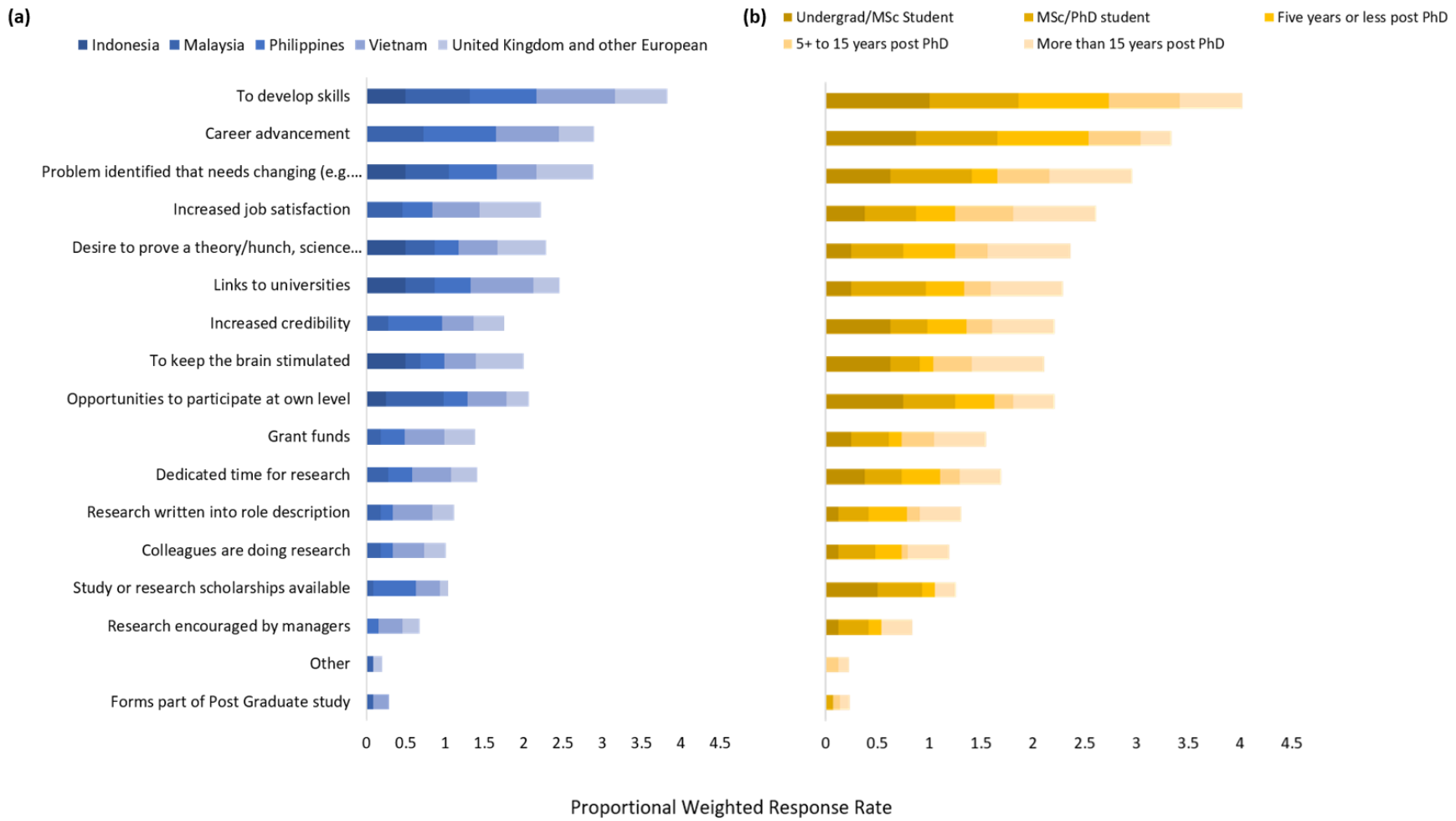

Figure 5 Personal motivators to research, according to participants of the Blue Communities project. Respondents could choose as many options as were relevant. The bars are weighted according to the total number of respondents from (a) each country/region, and (b) their career stage (e.g. if every respondent chose an option, each bar segment would have a value of 1).

Across both broad regions, 66% of respondents strongly agreed that they worked with interdisciplinary teams (Figure 6 E); 91% agreed or strongly agreed that they feel positive about working with people from different disciplines in the future (Figure 6 O) and 89% that they had the opportunity to lead research (Figure 6 M). 68% of respondents agreed or strongly agreed that they had the chance to lead a publication (Figure 6 K), of these 76% were from SE Asia. Leading publications was associated with age ($p=0.012$; Table S3) and career stage ($p=0.021$), with the youngest and least experienced, and oldest and most experienced not having led publications. On the whole, respondents from SE Asia responded more positively across all statements. Respondents from SE Asia strongly agreed that their research was relevant for making an impact in their region (making a difference to society), but this was less clear for UK respondents (Figure 6 A; $p<0.001$ Table S3). They also particularly agreed that they led on their own research questions (Figure 6 L; $p=0.008$), they learnt new skills (Figure 6 J, $p < 0.001$), and their career prospects improved (Figure 6 C, H; $p=0.041$, $p=0.015$) compared to more neutral responses from UK researchers on these.

Figure 6 Level of agreement to a number of statements from (a) Southeast Asian, and (b) UK (and other European) respondents. A five-point scale was used: Strongly disagree (-2), Disagree (-1), Neither agree nor disagree (0), Agree (1) and Strongly agree (2). Larger square and darker colour indicates higher frequency of responses in the matrix plot. Statements A-Q are abbreviated in the Figure, full statements are given in Table S4, Supplementary Material.

At the individual level, across both broad regions, most respondents were confident in their success and/or skill on most aspects of research capacity, with 64% of ratings across skills being at a score of

7 or higher (Figure 7), and with no sufficient evidence of a difference in success or skill between the regions on any aspect (Table S5). Respondents in both regions were most confident in finding and critically reviewing literature (Figure 7 E, G) with 84% scoring themselves 7 or higher. 79% of respondents scored 7 or higher in presenting research (J) and 77% in protocol/study design (T). 75% scored 7 or higher in understanding interdisciplinary approaches and issues (P). Areas of lower confidence for respondents were in submitting a health and safety assessment (M; 32% scored 7+), financial claims (O; 41% scored 7+), in securing research funding (L; 45% scored 7+) and in submitting ethics applications (N; 52% scored 7+).

Self-assessed success or skill in the different aspects generally was not associated with demographic variables, except in a few circumstances. There was evidence of association with age and data collection ($p=0.05$, Table S5), where the 31-50 yr old age category scored themselves highest; and age and reviewing literature ($p=0.04$), where older age categories scored themselves higher. Early career researchers (up to PhD student), scored themselves lower on finding literature ($p=0.02$) and on publishing ($p=0.04$). There was an association with gender and the scores on quantitative analysis, where some female researchers scored themselves very low ($p<0.001$).

In terms of change following involvement with the Blue Communities project, all but one respondent saw improvement in the understanding of overseas issues (Figure 7 Q). Southeast Asian partners indicated higher improvement across 14 out of 22 markers of research capacity compared to UK partners who mainly indicated no change or a smaller degree of improvement across most markers (Figure 7, Table S5). SE Asian respondents saw greater improvement in collecting data (D, $p<0.001$), finding and critically reviewing literature (G, $p<0.001$, E, $p<0.001$), questionnaires (F, $p<0.001$), managing projects (H, $p=0.018$), presenting research (J, $p=0.008$), networking (I, $p<0.001$), referencing and data management systems (R, $p=0.001$, S, $p=0.027$), research reports and publications (U, $p=0.002$, V, $p=0.008$) and understanding interdisciplinary approaches and issues (P, $p=0.001$). Similar to UK respondents, they mostly saw no change submitting health and safety

306 applications (M, p=0.51) and in financial claims (O, p=0.12). There was no association between other
307 demographic variables and the degree of improvement reported.

308 There was evidence to suggest a positive correlation between the current success or skill of
309 individuals and the degree of improvement during the BC project in 18 out 22 aspects for SE Asian
310 respondents and in 2 aspects (providing advice (K) and submitting finance claims (O)) for UK
311 participants (Figure 7). Together this evidence indicates that SE Asian respondents, on most aspects,
312 perceived that they had improved from a lower success or skill level to achieve the same success or
313 skill level that UK respondents started the project with.


A Qualitative Analysis
R = 0.16, p = 0.56
R = 0.73, p = 2.5e-07
B Quantitative Analysis
R = −0.012, p = 0.96
R = 0.4, p = 0.013
C Apply funding
R = 0.27, p = 0.29
R = 0.72, p = 1.2e-06
D Data collection
R = 0.36, p = 0.17
R = 0.3, p = 0.078
E Review literature
R = 0.089, p = 0.73
R = 0.44, p = 0.0067
F Questionnaires
R = 0.27, p = 0.27
R = 0.47, p = 0.0041
G Finding literature
R = −0.2, p = 0.42
R = 0.28, p = 0.099
H Manage a project
R = 0.11, p = 0.67
R = 0.69, p = 3.7e-06
I Networking
R = 0.34, p = 0.17
R = 0.43, p = 0.0074
J Present research
R = −0.064, p = 0.81
R = 0.68, p = 4e-06
K Provide advice
R = 0.57, p = 0.013
R = 0.45, p = 0.0063
L Secure grants
R = 0.47, p = 0.055
R = 0.76, p = 9.5e-08
M Health and Safety
R = 0.22, p = 0.39
R = 0.85, p = 3.6e-09
N Ethics
R = −0.033, p = 0.9
R = 0.74, p = 7e-07
O Finance claims
R = 0.53, p = 0.035
R = 0.64, p = 8.9e-05
P Interdisciplinary approaches
R = 0.23, p = 0.37
R = 0.32, p = 0.054
Q Overseas issues
R = 0.084, p = 0.74
R = 0.46, p = 0.0036
R Referencing System
R = −0.33, p = 0.18
R = 0.21, p = 0.22
S Data management
R = 0.061, p = 0.82
R = 0.62, p = 4.2e-05
T Protocol or Study Design
R = −0.063, p = 0.8
R = 0.49, p = 0.0019
U Research report
R = −0.38, p = 0.13
R = 0.43, p = 0.0066
V Publication
R = 0.34, p = 0.17
R = 0.47, p = 0.0029
Change in success or skill following involvement in BC
Current Success or Skill Level
Region
SE Asia
UK

Figure 7 The relationship between Southeast Asian respondent and UK (and other European) respondent perceptions of their personal (individual level) current success or skill level for each aspect of research capacity (1=no success/skill and 9=highest possible success/skill) and change in success or skill level for each aspect as a result of involvement in the Blue Communities (BC) project (Rating scale categories converted to numbers where –2 is 'Much worse', 0 is 'no change' and +2 is 'Much better'). Trend line, R and p values indicate Spearman rank correlation. Note that discrete data points are 'jittered' for visualisation purposes. Research capacity aspects A-V are abbreviated in Figure, full statements given in Table S6, Supplementary Material.

3.3 Team Level Research Capacity

At the team level (the participant's Blue Communities team at their own institution), most respondents across both broad regions were confident in the success or skill of their team across most research capacity markers, with 74% of ratings across skills being at a score of 7 or higher and with insufficient evidence of a difference in success or skill between the regions on any aspect (Figure 8, Table S7). 86% of respondents scored their team 7 or higher for publications (Figure 8 U), 82% for research opportunities (R) and 80% for having leaders that support research (Q). On other aspects, there was lower confidence with 63% scoring their team 7 or higher for having incentives and support for mentoring (N) and for availability of software to support research activities (P), and 64% for having adequate resources to support staff training (J). There was evidence of an association with career stage and disseminating research (B, p=0.044), with early career groups (up to 5 years post PhD) scoring their teams highly on this; their team's success in providing expert advice (K, p=0.010), with MSc/PhD students scoring their teams lower on this, and scholarships (T, p=0.041), with MSc/PhD students and those up to 5 years post PhD scoring their teams lower on this. More experienced researchers (p=0.007) and those on permanent contracts (p=0.035) scored their teams higher on software (P). Male researchers were associated with a lower team score for engaging with external partners (L, p=0.025).

In terms of change following involvement with Blue Communities, there was disparity between groups, with SE Asian partners finding most aspects to be better or much better and UK respondents mostly reporting no change (Figure 8). SE Asian respondents reported significantly higher improvement than UK respondents on all aspects except scholarships (T) (Table S7). There was no association with age, gender, career stage or contract type and the level of improvement.

There was evidence to suggest a positive correlation between the current success or skill of teams and the degree of improvement during the BC project in 11 out 21 aspects for SE Asian respondents

and in 2 aspects (staff being involved in research planning (D) and staff training (J)) for UK respondents (Figure 8). Together this evidence indicates that SE Asian respondents, on around half of research capacity markers, perceived that their teams had improved from a lower success or skill level to achieve the same success or skill level that UK teams started the project with.


A Impactful research
R = 0.32, p = 0.27
R = 0.46, p = 0.0038
B Disseminates research
R = 0.35, p = 0.22
R = 0.29, p = 0.076
C Planning with evidence
R = 0.15, p = 0.63
R = 0.41, p = 0.011
D Team level planning
R = 0.39, p = 0.24
R = 0.32, p = 0.057
E Staff involved in plans
R = 0.67, p = 0.024
R = 0.44, p = 0.0071
F Data management
R = 0.055, p = 0.85
R = 0.044, p = 0.8
G Ethics
R = 0.063, p = 0.82
R = 0.13, p = 0.45
H Finance management
R = 0.083, p = 0.78
R = 0.14, p = 0.43
I Health and Safety
R = 0.25, p = 0.4
R = 0.29, p = 0.078
J Staff training
R = 0.64, p = 0.025
R = 0.24, p = 0.16
K Expert advice
R = 0.37, p = 0.19
R = 0.4, p = 0.014
L External partners
R = −0.1, p = 0.72
R = 0.26, p = 0.13
M Funds, equipment, admin
R = 0.52, p = 0.059
R = 0.35, p = 0.037
N Mentoring
R = 0.54, p = 0.072
R = 0.47, p = 0.0041
O Research quality
R = 0.46, p = 0.11
R = 0.37, p = 0.029
P Software
R = 0.19, p = 0.5
R = 0.56, p = 0.00051
Q Leaders support research
R = 0.27, p = 0.33
R = 0.45, p = 0.005
R Research opportunities
R = 0.22, p = 0.45
R = 0.31, p = 0.061
S Interdisciplinary approach
R = 0.12, p = 0.69
R = 0.32, p = 0.055
T Scholarships
R = 0.13, p = 0.69
R = 0.49, p = 0.0026
U Publication
R = −0.15, p = 0.61
R = 0.33, p = 0.05
Change in success or skill following involvement in BC
Current Success or Skill Level
Region
SE Asia
UK

351

352 **Figure 8** The relationship between Southeast Asian respondent and UK (and other European) respondent perceptions of their team's current success or skill
353 level for each aspect of research capacity (1=no success/skill and 9=highest possible success/skill) and change in success or skill level for each aspect as a
354 result of involvement in the Blue Communities (BC) project (Rating scale categories converted to numbers where –2 is 'Much worse', 0 is 'no change' and +2
355 is 'Much better'). Trend line, R and p values indicate Spearman rank correlation. Note that discrete data points are 'jittered' for visualisation purposes.
356 Research capacity aspects A-U are abbreviated in Figure, full statements given in Table S8, Supplementary Material.

357

3.4 Organisational Level Research Capacity

At the organisational level, again most researchers rated their organisation's success or skill highly across all or most research capacity markers in both broad regions, with 66% of ratings across skills being at a score of 7 or higher (Figure 9). 77% of respondents scored their institutions 7 or higher for accessing external funding for research (Figure 9 A), encouraging research activities relevant to creating impact (B), and for supporting the peer reviewed publication of research (T). While only 54% of respondents scored their institutions 7 or higher for ensuring organisational planning is guided by evidence (D) and ensuring staff career pathways are available in research (E). Only for having adequate support for staff training (K), did UK respondents score their institutions higher than SE Asian respondents ($p=0.049$, Table S9). For this aspect, 72% of UK respondents and 47% of SE Asian respondents scored their institutions 7 or higher. There was an association with career stage and scores attributed to some aspects. Later career researchers (more than 15 years post PhD), scored their institutions higher on getting external funding (A, $p=0.046$), their institutions access to software (Q, $p=0.011$) and on the interdisciplinary approach (S, $p=0.041$).

In terms of improvement following involvement with Blue Communities, SE Asian respondents reported some improvement ('Better') across all markers and overall higher improvement than UK respondents across all markers, who reported mostly no change (Figure 9, Table S9). There was evidence of an association with gender on degree of improvement on two aspects, with females more likely to report no improvement at their institution for research development policy (F, $p=0.006$) and ethics (H, $p=0.005$).

381 There was evidence to suggest a positive correlation between the current success or skill of
382 institutions and the degree of improvement during the BC project in 11 out 20 aspects for SE Asian
383 respondents and in 1 aspect (publication (T)) for UK participants (Figure 8). Together this evidence
384 indicates that SE Asian respondents, on around half of the research capacity aspects, perceived that
385 their institutions had improved from a lower success or skill level to achieve the same success or skill
386 level that UK institutions started the project with.

387

388

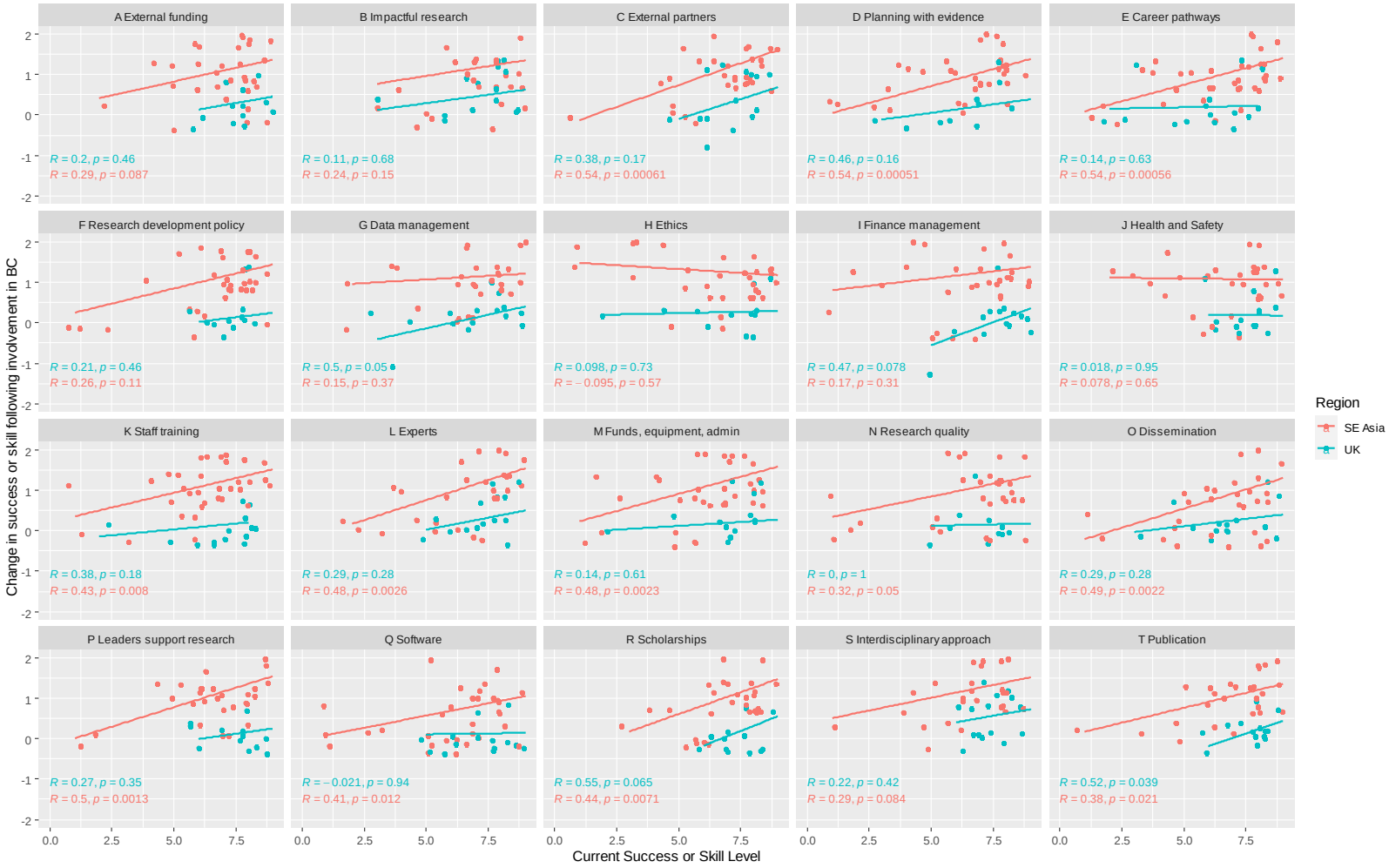
A External funding
B Impactful research
C External partners
D Planning with evidence
E Career pathways
F Research development policy
G Data management
H Ethics
I Finance management
J Health and Safety
K Staff training
L Experts
M Funds, equipment, admin
N Research quality
O Dissemination
P Leaders support research
Q Software
R Scholarships
S Interdisciplinary approach
T Publication
R = 0.2, p = 0.46
R = 0.29, p = 0.087
R = 0.11, p = 0.68
R = 0.24, p = 0.15
R = 0.38, p = 0.17
R = 0.54, p = 0.00061
R = 0.46, p = 0.16
R = 0.54, p = 0.00051
R = 0.14, p = 0.63
R = 0.54, p = 0.00056
R = 0.21, p = 0.46
R = 0.26, p = 0.11
R = 0.5, p = 0.05
R = 0.15, p = 0.37
R = 0.098, p = 0.73
R = −0.095, p = 0.57
R = 0.47, p = 0.078
R = 0.17, p = 0.31
R = 0.018, p = 0.95
R = 0.078, p = 0.65
R = 0.38, p = 0.18
R = 0.43, p = 0.008
R = 0.29, p = 0.28
R = 0.48, p = 0.0026
R = 0.14, p = 0.61
R = 0.48, p = 0.0023
R = 0, p = 1
R = 0.32, p = 0.05
R = 0.29, p = 0.28
R = 0.49, p = 0.0022
R = 0.27, p = 0.35
R = 0.5, p = 0.0013
R = −0.021, p = 0.94
R = 0.41, p = 0.012
R = 0.55, p = 0.065
R = 0.44, p = 0.0071
R = 0.22, p = 0.42
R = 0.29, p = 0.084
R = 0.52, p = 0.039
R = 0.38, p = 0.021
Change in success or skill following involvement in BC
Current Success or Skill Level
Region
SE Asia
UK

Figure 9 The relationship between Southeast Asian respondent and UK (and other European) respondent perceptions of their organisation's current success or skill level for each aspect of research capacity (1=no success/skill and 9=highest possible success/skill) and change in success or skill level for each aspect as a result of involvement in the Blue Communities (BC) project (Rating scale categories converted to numbers where –2 is 'Much worse', 0 is 'no change' and +2 is 'Much better'). Trend line, R and p values indicate Spearman rank correlation. Note that discrete data points are 'jittered' for visualisation purposes. Research capacity aspects A-T are abbreviated in Figure, full statements given in Table S10, Supplementary Material.

4. Discussion

This paper has presented quantitative data from a diverse group of researchers on the impact of the research capacity building activity in an internationally collaborative project that has taken the specific approach of '*learning-by-doing'*. Generally, this appears to have been a successful strategy based on the largely positive perceptions of the respondents to this survey but was particularly successful at the individual level with respondents from SE Asia, who attributed clear improvements across 18 out 22 aspects of research capacity to their involvement in the Blue Communities project. Here, evidence for building and strengthening of research capacity through this project was based on the perceptions of participants who were at the end of the four-year project period and is discussed in the important context of its sustainability into the future to address the ongoing global challenges.

4.1 Successes, or what worked well for current and future research capacity

The skills and opportunities valued most by the respondents of this study were interdisciplinary and international working to make a difference to society and 91% felt positive about continuing to work in this way in the future; one respondent reflected on "*working with amazing international partners on issues that matter*" (BC project participant, UK) and another could see impact in their local community: "*the great response of the communities to our engagements*" (BC project participant, Philippines). Respondents from SE Asia, in particular, could see that their research was relevant for making an impact in their region. While researchers recognised the challenges and benefits of this type of working, "*Having differing disciplines within the team is enriching and engaging despite the conflicts that came with it*" (BC project participant, Malaysia), building trusting relationships between partners, with integration and collaboration, is one of the key requirements of a successful interdisciplinary capacity building project and keeping people engaged in the process (Steelman et al., 2021, McClure, 2020, Harvey et al., 2022, Woodhill, 2010). Capacity building is not only about

transferring traditional skills but also about "*a process of strengthening relationships that enable innovation and resilience in communities, organisations and societies*" (Woodhill, 2010), thus, the process of collaborating and working together builds capacity in itself (Grieve and Mitchell, 2020). The results of this survey are evidence that the researchers involved are enthusiastic, passionate and engaged in working collaboratively and making a difference to society. And importantly respondents expressed their hopes for continuing to work this way in the future: "*I hope to continue to cooperate in the future, to develop the research direction of the project*" (BC project participant, Vietnam).

One clear example of *learning-by-doing* in action was in carrying out evidence synthesis and systematic reviews. During the project a team of UK researchers who are very experienced in systematic reviews ran a series of training sessions and provided ongoing guidance and support to SE Asian researchers in developing their own systematic reviews with research questions relevant for their region. This approach was clearly successful in that researchers in SE Asia identified critically reviewing literature as being a factor they are particularly skilled or successful at, and identified this as an area of much improvement because of involvement with the project. Three systematic reviews were carried out for three of the SE Asian partner countries, all led by SE Asian researchers (publications in progress). In addition, protocols for carrying out reviews were also developed and published (Zain et al., 2022, Nguyen et al., 2020). Furthermore, participants in the workshops have since gone on to teach the method to others in their institution, demonstrating the sustainable nature of this capacity building.

Notably, lead authorship in the Blue Communities project amongst the respondents was well distributed between those from different countries and respondents clearly appreciated this, as one respondent described their team's motivation as being "*the independence granted to develop and pursue research questions*" (BC project participant, Indonesia). This is in contrast to many studies that show disparity in lead authorship between high- and low-income partner countries. For

example, Harvey et al. (2022) found only 14% of 230 publications considered were led by a researcher from an African institution. Interdisciplinary research, by nature, requires input from a diversity of partners coming from different knowledge backgrounds but power imbalances can mean that these different actors do not always contribute sufficiently (Steelman et al., 2021). A key feature of Blue Communities was that it was decided from the outset that early career researchers, in particular those from SE Asian partner institutions, would be prioritised in terms of leading research and publications, and were supported by more senior staff in doing this. In addition, the project established an Early Career Researcher Network, that encouraged members to apply for additional funding to support their own research questions, host seminars and share skills. Having this set out clearly and supported with leadership meant these power imbalances were explicitly addressed.

The COVID pandemic restrictions presented a challenge, as reported by respondents, especially SE Asian participants. This was through inability or reduced time to visit field sites and collect new data, inability to meet project partners in person, and potentially more difficulty with internet or resource access, as well as other personal factors. This is likely to have impacted capacity building through impacting development of personal relationships. Despite this, partners responded positively in terms of improvement across most research capacity markers. Teams adapted quickly to the new situation and in some cases changed their focus. Indeed, partners in the project demonstrated good practice in moving activities online in a sensitive and structured way (Richter et al., 2021). In some, but not all cases, project participants recognised that they were fortunate to have the pandemic come later in the project so that personal relationships were already well established. However, where this was not the case, partners demonstrated concerted effort in building relationships online. For example, Richter et al. (2021) emphasised the importance of using icebreakers in the virtual environment. This made a relatively smooth transition to moving capacity building elements and research working online.

Most respondents felt positive on a personal level about leading research questions and publications, learning new skills, and improving their career prospects. One respondent reflected: "*my involvement at the Blue Communities has increased my visibility in the local academia. This program has also significantly impacted my research and project management skills. Most importantly, my involvement with the Blue Communities has paved my career path in significant ways*" (BC project participant, Malaysia). This shows that concrete and sustainable capacity building has been achieved during the project, so that partners can carry on with this type of research independently into the future.

4.2 Challenges for sustainable current and future research capacity

An issue identified previously in research projects that aim to create impact in solving global challenges and build capacity is the conflict between research aims (e.g. advancing knowledge and publishing papers), influencing policy and building capacity (Harvey et al., 2022). Harvey *et al*. acknowledge that a common strategy is often used to achieve these aims, but this may not be appropriate for all, and research aims can be given priority. This conflict clearly emerged during the Blue Communities project. The majority of respondents to the survey were on fixed term contracts and, traditionally, publishing papers is important for career advancement, while even established researchers depend on their publication record in winning further research funding. Younger researchers in particular valued publishing papers and further employment opportunities, but publishing was important for many respondents with several mentioning publishing papers as a motivator for their team, and one respondent describing the motivation to be the "*Esteem and recognition for good research published, contributing to career development and attraction of further research funding for self-determined research pathways*" (BC project participant, UK). However, tension with these motivations and the aims of building capacity and achieving real impact

in communities and how this is recognised for individuals, was also felt, as one respondent described: "*I'd say some team members are too obsessed with papers as a marker of success, and universities do not sufficiently recognise the value of impact in their promotion criteria*" (BC project participant, UK).

This tension may be driven particularly by the UK side where researchers may feel under more pressure to publish for their career progression and to meet expectations of funding bodies. For example, one SE Asian respondent noted that "*I'm now appointed as a Senior Lecturer at a local university, and one thing that got me into this job is because my employer values my networking with the international, multidisciplinary research team of BC"* (BC project participant, Malaysia) indicating that the values in UK universities differ from those that may be found in other cultures (Hoang, 2021). Overall, across almost all markers and at all levels, SE Asian participants reported more positive improvement than UK participants. Several factors may explain this e.g. the markers given may not capture adequately what UK participants may have benefited from nor what adequately evaluates interdisciplinary aspects of research capacity (Steelman et al., 2021). However, it could also be that in some cases participants felt capacity building was acting mainly in one direction. For example, one respondent said "*Compared to traditional research projects, the career progression opportunities for UK teams may have [conversely] advanced less. The focus was on capacity development, rightly, but this may have inadvertently reduced the scientific innovation and output from UK teams because of the amount of time needed to support the partner teams*" (BC project participant, UK). While most agreed that they learnt new skills and project managed, if these attributes are not obviously valued in their career pathways, individuals may also not value these highly. Considering that interdisciplinary researchers tend to publish less at first and have greater difficulty in demonstrating research productivity than more traditional researchers (Steelman et al., 2021), the perceived lack of career development in this type of project will only exacerbate the conflict between research aims, building capacity and making impact. The increasing importance of impact in the UK's evaluation of Higher Education providers through evaluations by funding bodies

such as the UK Research and Innovation's (UKRI) Research Excellence Framework and Knowledge Excellence Framework may go some way towards valuing and incentivising researchers who participate in capacity building research.

In some cases, within the project, researchers did prioritise research aims. Other studies of international consortia have reported that researchers in the Global South can feel like 'data sources' in that they are not heavily involved in planning or analysing data, but only in commenting on it; that responsibility stays in the North (Harvey et al., 2022). In the Blue Communities project, researchers from both regions were involved in the collection of data to some degree, and it was clear that SE Asian respondents were involved in all aspects of research, from planning, to collecting data, to analysing and interpreting. There were instances throughout the project where SE Asian partners sometimes deferred to UK partners to carry out complex analyses. For example, one respondent observed: "*Some* [sub-]*projects, while providing training at annual meetings, ended up doing the analysis for the partners rather than training and then letting partners take ownership of the research. This is reflected in some* [sub-]*projects not having many papers lead authored by* [SE Asian] *partners*" (BC project participant, UK). Harvey et al. (2022) emphasised the importance of being willing to fail as part of a learn-by-doing process, thus sometimes sacrificing high-impact research outputs to focus on capacity development.

It was unexpected that UK respondents did not feel more strongly that their research capacity improved, in particular in relation to applying and understanding interdisciplinary approaches. UK respondents only strongly identified improvement in a greater understanding of overseas issues. This particular marker may encompass a multitude of factors, and it may be that the parameters provided in the survey do not adequately articulate what UK researchers did learn from involvement with the project. It is important to identify these parameters and ensure more active two-way dialogue in future collaborations, so that UK or other participants from HIC are mutually learning from their project partners. Although UK researchers may have seen themselves more in the role of

548 delivering research capacity than receiving it, there are important reasons for mutual learning and
549 capacity strengthening. UK researchers did not identify the project as having an impact in their
550 region. This is not totally unexpected since UK partners were not working directly with local
551 communities as SE Asian partners were. However, there are areas that could have potential impact
552 in the UK. For example, the current discourse in the UK on the need to decolonise the curriculum
553 (Schucan Bird and Pitman, 2020) would clearly benefit from researchers who have experience
554 working with other cultures and introducing this diversity through their teaching and research
555 citations. In addition, researchers working directly with communities in LIC on sustainability issues
556 try to highlight the knowledge that is held in the Global South as "*the limited Western view of*
557 *sustainability is stifling progress*" (Nagendra, 2018). SE Asian partners instigated a wealth of
558 approaches throughout the project, working creatively with local communities and practitioners. For
559 example, researchers in Indonesia carried out participatory film making with local communities
560 addressing sustainability issues. This resulted in changes in environmental behaviours and the
561 formation of a film making community group dedicated to making audio visual work on behavioural
562 change related to plastic pollution and climate change. Another example from Malaysia saw
563 engagement with local communities resulting in greater attendance to health centres and vaccine
564 uptake. More work is needed to reflect on and recognise the learning of UK partners in this
565 collaboration. However, this may become more apparent over the longer term than at the point this
566 survey was carried out.

567 There was disparity in resources at organisational level between UK and SE Asia, with SE Asian
568 respondents identifying having inadequate resources to support staff research training, while UK
569 respondents reported their organisations were good in this. In other studies, participants have felt
570 that it is important to recognise this organisational inequality to manage expectations and ensure a
571 meaningful partnership (Grieve and Mitchell, 2020). The level of improvement at the institutional
572 level was perceived by SE Asian respondents to be more limited than at the individual level, with
573 improvement in only around half the markers correlating with the current success. Development is

still needed at an institutional or organisational level to reduce inequality in these factors, as there can be a lack of investment at higher levels, beyond the individual (Harvey et al., 2022). Despite this, SE Asian and UK respondents felt that they would build upon the international networks and relationships developed through the project.

Many respondents felt lower confidence in submitting health and safety assessments, financial claims, and ethics applications, though at an individual level, there were improvements in these for SE Asian respondents, and improvement in financial claims for UK respondents. At team and institution level, these areas were not perceived to have improved. While not all respondents would have needed to participate in these aspects, and that may explain some of the variability, these aspects may reflect a lack of facilities or support for these within organisations but also that they can be complex administrative processes where rules can be unclear even where facilities are well developed. For example, one respondent mentioned the "*bureaucracy of financial process*" (BC project participant, Philippines) as a barrier to their team. Additionally, ethics applications are often reviewed by individuals on an ethics committee and responses to applications can depend strongly on the individual reviewers which can vary from organisation to organisation. Similar studies have also found efficiency of researchers to be inhibited by bureaucracy or technical and administrative support in time-limited research projects (Grieve and Mitchell, 2020, Harvey et al., 2022). This project worked with organisations to develop their ethical approval processes, financial management and risk assessment, and there is variability in these depending on the specific location. One respondent mentioned a team barrier as being "*lack of administrative support in the initial stage of project*" (BC project participant, Malaysia), indicating that things did improve. Despite lower confidence indicated by respondents on these aspects, from the personal observations of the principal investigator and project manager (authors MA and VC on this paper), there was substantial improvement of SE Asian individual, team and to some extent organisational capacity in financial claims and ethics processes. This project, through learning-by-doing, adapted a flexible approach, to meet the needs of researchers in different countries and organisations and adapt to their specific

600 circumstances. This included, for example, providing advances on funding to allow participants to
601 travel or take part in research activities and circumvent inhibitive administrative processes.

602 ### *4.3 Study limitations*

603 There are limitations to this study, specifically that most respondents came from academia, and to
604 fully evaluate a transdisciplinary project, the perspectives of other actors, such as community
605 partners, are also needed (Steelman et al., 2021). The survey was also only available in the English
606 language and this would have excluded some potential respondents. It is likely that the response to
607 the English language acting as a barrier is an underestimate for this project, and ideally the survey
608 would be translated to local languages to reach and get perspectives of all participants.

609 Furthermore, a longer-term assessment of research capacity will be required to evaluate if it has
610 sustained into the future beyond the life of the project (Vallejo and Wehn, 2016, Hewitson, 2015).
611 However, this study provides a broader perspective on the success of a learning-by-doing approach
612 to building research capacity than focussing on research outputs such as publications and funding
613 alone. There are key lessons emerging from the outputs of this study that can be used to enhance or
614 modify approaches used for capacity building in future collaborations.

615 ### *4.4 Conclusions*

616

617 There is currently a difficult balance between undertaking innovative interdisciplinary research that
618 has societal impact and building sustainable research capacity. In this case, the Blue Communities
619 project would appear to have achieved advances in all of these areas. This may provide lessons for
620 other interdisciplinary research collaborations and capacity building efforts. The Blue Communities
621 approach placed a strong emphasis on building relationships from the inception of and throughout
622 the project, through a collaborative learn-by-doing process, that kept people enthusiastic and
623 engaged to the end. However, gaps were identified by respondents in scientific innovation and in
624 particular aspects of research capacity, and much of this may have arisen from trying to achieve

what can be seen as conflicting aims. Despite the project recognising the importance of interactive dialogue and not just one-way training, for mutual capacity building (Richter et al., 2021), UK respondents reported less capacity built across most parameters. While this needs further investigation and other factors may come into play, this may in part be driven by the values of UK organisations. Institutions are responsible for incentivising individual's actions (Woodhill, 2010). Currently, the incentives around research and career progression within research, particularly amongst HIC are focused on publishing papers, and interdisciplinary researchers face challenges in having their achievements and skills recognised in traditional academic career paths (Radinger-Peer et al., 2022, Fam et al., 2020, Guimarães et al., 2019). Institutions and employers need to increase their efforts to place greater value on the contributions people make in the areas of strengthening capacity and making societal impact giving it equal, or higher value to research publications. This is essential to mobilising interdisciplinary and transdisciplinary research to solve global challenges and achieve long term sustainability. The current academic system is a major barrier to achieving this long-term sustainability where people undertaking research will ultimately need to think about their own career progression, and their own financial stability and security.

Acknowledgements

This study was funded by the Global Challenges Research Fund (GCRF) via the United Kingdom Research and Innovation (UKRI) under grant agreement reference NE/P021107/1 Blue Communities, which aimed to understand the well-being benefits and risks of coastal living in Southeast Asia. Author FC was also supported by the University of Liverpool through its Postgraduate Certificate in Academic Practice (PGCAP) programme. Thanks to all participants of the Blue Communities project who responded to the survey. Thanks to Carla-Leanne Washbourne and Keisuke Okamura for reviewing a previous draft of this paper.

Authorship Contribution

All authors conceived the study. FC adapted a pre-developed survey for the current situation and all authors reviewed the survey. FC carried out the data collection, analysis and prepared the original draft. All authors reviewed and edited the manuscript for publication.

Data Availability

Data are available in an open access archive, the UK Data Service, in an aggregated format which protects the identity of the respondents: **Culhane, Fiona E.** and **Cheung, Victoria** and **Austen, Melanie** (2022). *Self-reported Change in Research Capacity Following Participation in an Interdisciplinary Research Project, 2017-2021.* [Data Collection]. Colchester, Essex: UK Data Service. 10.5255/UKDA-SN-856101

Declarations

Conflict of Interest

Author MA was the Principal Investigator; VC was the Project Manager; and FC was a Research Fellow in Blue Communities.

Ethics Approval

Ethics approval was obtained from the University of Plymouth ethics committee with written support obtained from leaders of each institution where participants are based.

Consent for publication

Consent for this study was obtained from survey respondents on the basis that their anonymity and confidentiality is protected.

Supplementary Material

Survey Questions (note numbers refer to corresponding the numbers in the open access data file)

Filter Questions:

7. Do you currently or have you previously carried out research as part of the Blue Communities project?

Yes/No

Section 1: Demographic Questions

8. What is your gender: Male/Female/Prefer not to say

9. What is your age group: 18-30; 31-50; 51-64; 65+; Prefer not to say

10. What sector do you work in: Academia, NGO, other (please state if other)

11. What research experience do you have? Undergraduate degree; Current Masters student; Researcher (post Masters, no PhD); PhD student; </= 5 years post PhD; >5-15 years post PhD; >15 years post PhD; other

12. What is your contract type at your institution: Fixed Term; Permanent

13. In which country is your main institution located: Indonesia; Malaysia; Philippines; United Kingdom; Vietnam

14. Choose the option that best describes your association with the Blue Communities project (for the majority of the time you have worked on the project):

- I work only on the Blue Communities project or Blue Communities is my main research project
- My time is divided amongst multiple research projects, of which Blue Communities is one
- Blue Communities is my only research project but I also have other work commitments such as teaching or administrative work
- My time is divided amongst multiple research projects, of which Blue Communities is one and I also have other work commitments such as teaching or administrative work
- None of these options describe my association with the Blue Communities project

Section 2: Individual Level

15. Please indicate any research activity you are currently involved with or have been involved with as part of Blue Communities. Tick as many as apply

- Writing a research report, presentation or paper for publication
- Writing a research protocol or designing a study
- Submitting an ethics application
- Submitting a health and safety assessment
- Collecting data e.g. surveys, interviews
- Data management
- Analysing qualitative research data
- Analysing quantitative research data
- Writing a literature review
- Applying for research funding
- Networking
- Project management
- Interdisciplinary research approaches and issues
- Secured research funding
- Co-authored a paper for publications
- Presented research findings at a conference
- Submitted financial claims from a research grant
- Other

16 (a) Based on your perception, rate your personal current success or skill level for each of the following aspects (1=no success/skill and 9=highest possible success/skill): 1-9/unsure

16 (b) And secondly, say whether you think this aspect has changed as a result of involvement with the Blue Communities project (on a scale of much worse – worse – no change – better – much better/unsure)

16.1	Finding relevant literature
16.2	Critically reviewing the literature
16.3	Using a computer referencing system (e.g. Endnote)
16.4	Writing a research protocol or designing a study
16.5	Securing research funding
16.6	Submitting an ethics application
16.7	Submitting a health and safety assessment
16.8	Submitting financial claims from a research grant
16.9	Designing questionnaires
16.10	Collecting data e.g. surveys, interviews
16.11	Using computer data management systems
16.12	Analysing qualitative research data
16.13	Analysing quantitative research data
16.14	Writing a research report
16.15	Writing for publication in peer-reviewed journals
16.16	Providing advice to less experienced researchers
16.17	Understanding interdisciplinary approaches and issues
16.18	Understanding overseas issues and challenges
16.19	Applying for research funding/writing research grants
16.20	Networking

16.21 Managing a project
16.22 Presenting research findings

17. Which of the following resources have you benefited from through the Blue Communities partnership? Tick all that apply

- Software
- Research supervision
- Time to undertake research
- Research funds
- Administrative support
- Training
- Library access (including online library access)
- Protocol development
- Access to expertise
- Database development and management
- Health and safety guidance
- Research ethics guidance
- Seminars
- Networking meetings
- Mentorship
- Other (please state)

18. What research skills or opportunities do you value the most from your experience in Blue Communities (tick up to three responses):

Publishing papers; Writing successful research grants; Developing a positive attitude to research; Further employment opportunities; Subject understanding and knowledge; Confidence; Specialist technical skills and knowledge; International collaboration; Project management; Opportunity to present and disseminate work; Sharing ideas; Transdisciplinary work; Access to mentors; Other

19. What are the barriers to research for you personally? Tick all that apply

- Lack of time for research
- Lack of suitable backfill (someone to fill your other work commitments)
- Other work roles take priority
- Lack of funds for research
- Lack of support from management
- Lack of suitable supervision/mentorship
- Lack of access to equipment for research
- Lack of administrative support
- Lack of software for research
- Isolation

- Lack of library/internet access
- Personal motivations
- Other personal commitments
- Desire for work/life balance
- Lack of a co-ordinated approach to research
- Lack of skills for research
- Intimidated by research language
- Intimidated by fear of getting it wrong
- English language
- Covid pandemic restrictions
- Availability of trained staff to consult or collaborate with
- Internet connectivity
- Lack of long term employment
- Other (please state)

20. What are your motivators to conduct research for you personally? Tick all that apply

- To develop skills
- Career advancement
- Increased job satisfaction
- Study or research scholarships available
- Dedicated time for research
- Research written into role description
- Colleagues are doing research
- Research encouraged by managers
- Grant funds
- Links to universities
- Forms part of Post Graduate study
- Opportunities to participate at own level
- Problem identified that needs changing (e.g. improving something your local community, benefitting environment, etc.)
- Desire to prove a theory/hunch, science curiosity
- To keep the brain stimulated
- Increased credibility
- Other

21. State how much you agree or disagree with the following statements as a result of your involvement in the Blue Communities programme (Rating scale):

21.1 The research I carried out during Blue Communities was relevant to creating impact (e.g. making a difference to society, SDGs, local communities, policies, management, etc.) in my region

21.2 I had the opportunity to lead research work and/or contribute ideas that directed the research

21.3 I learned new technical specialist skills

21.4 I have had the opportunity to be the lead author on one/more than one publication

21.5 I project-managed
21.6 I did not have time to learn all that I might have during Blue Communities
21.7 I wrote new research grants during my time on Blue Communities
21.8 I worked with interdisciplinary teams
21.9 I felt some types of training were missing from the Blue Communities project
21.10 I feel positive about working with people from different disciplines in the future
21.11 I have been able to answer some of my own research questions
21.12 I will build upon the international networks and professional relationships that have been developed through the Blue Communities programme
21.13 I could have led more work than I did during the Blue Communities project
21.14 I think I will have more opportunities available to enhance my future career as a result of the work I have conducted for the Blue Communities programme
21.15 My career level has progressed as a result of my involvement in Blue Communities
21.16 I thought the Blue Communities research could have been more interdisciplinary
21.17 My institution rewards or recognises my achievements linked to Blue Communities

Section 3 Team Level

22. (a) Based on your perception, rate your Blue Community team's (at your own institute) current success or skill level for each of the following aspects (1=no success/skill and 9=highest possible success/skill): 1-9/unsure

(b) And secondly, say whether you think this aspect has improved as a result of involvement with the Blue Communities project (on a scale of much worse – worse – no change – better – much better, unsure)

22.1 Has adequate resources to support staff research training
22.2 Has funds, equipment or admin to support research activities
22.3 Does team level planning for research development
22.4 Ensures staff involvement in developing that plan
22.5 Has team leaders that support research
22.6 Provides opportunities to get involved in research
22.7 Does planning that is guided by evidence
22.8 Conducts research activities relevant to creating impact (e.g. making a difference to society, SDGs, local communities, policies, management, etc.)
22.9 Supports applications for research scholarships/degrees
22.10 Has mechanisms to monitor research quality
22.11 Has experts accessible for research advice
22.12 Disseminates research results at research forums/seminars
22.13 Supports an interdisciplinary approach to research
22.14 Has incentives and support for mentoring activities
22.15 Has external partners (e.g. government agencies, communities, public) engaged in research activities/planning
22.16 Supports the peer-reviewed publication of research
22.17 Has software available to support research activities

22.18 Has adequate ethics support and planning
22.19 Has adequate health and safety support and planning
22.20 Has adequate data management support and planning
22.21 Has adequate finance management support and planning

23. What are the biggest barriers to research in your team? Free text

24. What are the biggest motivators to research in your team? Free text

Section 4 Organisation Level

25. (a) For each aspect, firstly rate *your perception* of your organisation's (e.g. your University, Research Centre, NGO, etc.) success or skill level (1=no success/skill and 9=highest possible success/skill): 1-9/unsure,

(b) And secondly, say whether you think this aspect has improved as a result of involvement with the Blue Communities project (on a scale of much worse – worse – no change – better – much better/unsure)

25.1 Has adequate resource to support staff research training
25.2 Has funds, equipment or admin to support research activities
25.3 Has a plan or policy for research development
25.4 Has senior managers that support research
25.5 Ensures staff career pathways are available in research
25.6 Ensures organisational planning is guided by evidence
25.7 Access external funding for research
25.8 Encourages research activities relevant to creating impact (e.g. making a difference to society, SDGs, local communities, policies, management, etc.)
25.9 Has software programs for analysing research data
25.10 Has mechanisms to monitor research quality
25.11 Has experts accessible for research advice
25.12 Supports interdisciplinary approaches to research
25.13 Has regular forums/bulletins to present research findings
25.14 Engages external partners (e.g. government agencies, communities, public) in research activities/planning
25.15 Supports applications for research scholarship/degrees
25.16 Supports the peer-reviewed publication of research
25.17 Has adequate ethics support and planning
25.18 Has adequate health and safety support and planning
25.19 Has adequate data management support and planning
25.20 Has adequate finance management support and planning

26. Any other comments: Free text

Supplementary Tables

Table S1 Associations between demographic variables based on Fisher exact test

Variable	Variable	Fisher Exact Test p value	Note
Gender	Age	0.009	more younger people are female
	Experience/Career stage	0.581	
	Contract	0.749	
	Country	0.083	
	Region	0.070	
Age	Experience/Career stage	0.004	older people have more experience
	Contract	0.142	
	Country	0.432	
	Region	0.429	
Experience	Contract	0.063	
	Country	0.008	people with less experience more likely to be from Asia but experienced people from both
	Region	0.017	people with less experience more likely to be from Asia but experienced people from both
Contract	Country	0.317	
	Region	0.517	

Table S2 Associations between individual level questions (linked to Figures 1-5 in the main text) with demographic variables based on Fisher exact test

Question	Explanatory Variable	Fisher Exact Test p value
Research Activity (Figure 1)	Gender (removed 'prefer not to say')	0.987
	Age (removed 'prefer not to say')	0.984
	Experience (Very small categories combined i.e. Undergratuate + Current MSc student; Post MSc (no PhD) + PhD student)	1.000
	Contract type	0.998
	Country	1.000
	Region	0.811
Resources (Figure 2)	Gender (removed 'prefer not to say').	0.950
	Age (removed 'prefer not to say')	0.973
	Experience (Very small categories combined i.e. Undergratuate + Current MSc student; Post MSc (no PhD) + PhD student)	1.000
	Contract type	0.985
	Country	0.981

	Region	0.002
Research skills and opportunities valued (Figure 3)	Gender (removed 'prefer not to say')	0.116
	Age (removed 'prefer not to say')	0.023
	Experience (Very small categories combined i.e. Undergratuate + Current MSc student; Post MSc (no PhD) + PhD student)	0.276
	Contract type	0.089
	Country	0.030
	Region	0.005
Barriers to research (Figure 4)	Gender (removed 'prefer not to say')	0.365
	Age (removed 'prefer not to say')	0.131
	Experience (Very small categories combined i.e. Undergratuate + Current MSc student; Post MSc (no PhD) + PhD student)	0.949
	Contract type	0.009
	Country	0.015
	Region	0.001
Motivators (Figure 5)	Gender (removed 'prefer not to say')	0.932
	Age (removed 'prefer not to say')	0.639
	Experience (Very small categories combined i.e. Undergratuate + Current MSc student; Post MSc (no PhD) + PhD student)	0.946
	Contract type	0.552
	Country	0.943
	Region	0.340

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929 **Table S3** Associations between individual level questions (linked to Figures 6 in the main text) with
930 demographic variables based on Fisher exact test

Demographic	Letter Code	Statement	Fisher exact test p value	Notes

	A	Relevant for Impact	0.297	
	B	Rewarded by institution	0.472	
	C	Career progressed	0.192	
	D	Wrote grants	0.812	
	E	Interdiscuplinary teams	0.011	Almost everyone agreed with this, older researchers agreed more strongly
	F	Carry on relationships	0.051	
	G	Lacking interdisciplinarity	0.358	
	H	Future career opportunities	0.0515	
Age	I	Project managed	0.047	Those in older age categories agreed with this while others showed a range of responses
	J	Technical Skills	0.113	
	K	Lead a publication	0.0125	The youngest age category disagreed with this statement, while most others agreed
	L	My own research questions	0.105	
	M	Lead research	0.209	
	N	Training missing	0.0995	
	O	Positive interd. Working	0.0435	Most strongly agreed with this, one group who preferred not to say their age were neutral/unsure
	P	Lack of time	0.274	
	Q	Could have led more	0.094	
	A	Relevant for Impact	0.212	
	B	Rewarded by institution	0.295	
	C	Career progressed	0.397	
	D	Wrote grants	0.836	
	E	Interdiscuplinary teams	0.559	
	F	Carry on relationships	0.894	
	G	Lacking interdisciplinarity	0.136	
	H	Future career opportunities	0.848	
	I	Project managed	0.259	
	J	Technical Skills	0.196	
Career/Experience	K	Lead a publication	0.021	Most individuals from all career stage groups agreed with this, but individuals from the most experienced group and from the least experienced groups disagreed
	L	My own research questions	0.115	
	M	Lead research	0.828	
	N	Training missing	0.668	
	O	Positive interd. Working	0.27	
	P	Lack of time	0.803	
	Q	Could have led more	0.048	PhD students and the most experienced researchers agreed that they could have led more
	A	Relevant for Impact	0.238	
	B	Rewarded by institution	0.103	
	C	Career progressed	0.847	
	D	Wrote grants	0.932	
	E	Interdiscuplinary teams	0.671	
	F	Carry on relationships	0.438	
	G	Lacking interdisciplinarity	0.221	
	H	Future career opportunities	0.476	
Contract	I	Project managed	0.362	
	J	Technical Skills	0.44	
	K	Lead a publication	0.692	
	L	My own research questions	0.508	
	M	Lead research	0.236	
	N	Training missing	0.1	
	O	Positive interd. Working	1	
	P	Lack of time	0.799	
	Q	Could have led more	0.477	
	A	Relevant for Impact	0.076	
Gender	B	Rewarded by institution	0.369	
	C	Career progressed	0.227	

	D	Wrote grants	0.0325	More males were neutral on this aspect, while females wither strongly disagreed or agreed and strongly agreed
	E	Interdiscuplinary teams	0.045	More males strongly agree with this, while females mostly agreed or strongly agreed
	F	Carry on relationships	0.463	
	G	Lacking interdisciplinarity	0.449	
	H	Future career opportunities	0.038	More males strongly agree with this, while females mostly agreed or strongly agreed
	I	Project managed	0.789	
	J	Technical Skills	0.178	
	K	Lead a publication	0.602	
	L	My own research questions	0.152	
	M	Lead research	0.957	
	N	Training missing	0.491	
	O	Positive interd. Working	0.0045	More males strongly agree with this, while females mostly agreed or strongly agreed
	P	Lack of time	0.456	
	Q	Could have led more	0.104	
Region	A	Relevant for Impact	0.0005	SE Asia researchers mostly strongly agreed, more UK researchers gave a neutral response
	B	Rewarded by institution	0.818	
	C	Career progressed	0.041	SE Asia researchers mostly strongly agreed, more UK researchers gave a neutral response
	D	Wrote grants	0.104	
	E	Interdiscuplinary teams	1	
	F	Carry on relationships	0.374	
	G	Lacking interdisciplinarity	0.206	
	H	Future career opportunities	0.0155	SE Asia researchers mostly strongly agreed, more UK researchers gave a neutral response
	I	Project managed	0.535	
	J	Technical Skills	0.0005	SE Asia researchers mostly strongly agreed, more UK researchers gave a neutral response
	K	Lead a publication	0.113	
	L	My own research questions	0.0085	SE Asia researchers mostly strongly agreed, more UK researchers gave a neutral response
	M	Lead research	0.6	
	N	Training missing	0.665	
	O	Positive interd. Working	0.512	
	P	Lack of time	0.603	
	Q	Could have led more	0.043	SE Asia researchers mostly responded neutrally, while UK researchers gave a range of responses here, but none strongly agreed

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933 **Table S4** Codes and full statement associated with Figure 6 in the main text

Letter code given in Figure	Full statement associated with code
A	The research I carried out during Blue Communities was relevant to creating impact (e.g. making a difference to society, SDGs, local communities, policies, management, etc.) in my region
B	My institution rewards or recognises my achievements linked to Blue Communities
C	My career level has progressed as a result of my involvement in Blue Communities
D	I wrote new research grants during my time on Blue Communities

E	I worked with interdisciplinary teams
F	I will build upon the international networks and professional relationships that have been developed through the Blue Communities programme
G	I thought the Blue Communities research could have been more interdisciplinary
H	I think I will have more opportunities available to enhance my future career as a result of the work I have conducted for the Blue Communities programme
I	I project-managed
J	I learned new technical specialist skills
K	I have had the opportunity to be the lead author on one/more than one publication
L	I have been able to answer some of my own research questions
M	I had the opportunity to lead research work and/or contribute ideas that directed the research
N	I felt some types of training were missing from the Blue Communities project
O	I feel positive about working with people from different disciplines in the future
P	I did not have time to learn all that I might have during Blue Communities
Q	I could have led more work than I did during the Blue Communities project

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935 **Table S5** Associations between individual level questions (linked to Figure 7 in the main text) with
936 demographic variables based on Fisher exact test

Demographic	Letter Code	Skill	Success Level Fisher Exact Test P value	Improvement Level Fisher Exact Test P value	Explanantory Notes
Age	A	Qualitative Analysis	0.378	0.497	
	B	Quantitative Analysis	0.15	0.9	
	C	Apply funding	0.386	0.578	
	D	Data collection	0.0476	0.178	31-50 year olds scored better overall
	E	Review literature	0.0361	0.789	Older age categories scored better
	F	Questionnaires	0.36	0.573	
	G	Finding literature	0.062	0.185	
	H	Manage a project	0.283	0.597	
	I	Networking	0.816	0.538	
	J	Present research	0.408	0.139	
	K	Provide advice	0.204	0.253	
	L	Secure grants	0.789	0.217	
	M	Health and Safety	0.854	0.638	
	N	Ethics	0.47	0.292	
	O	Finance claims	0.795	0.378	
	P	Interdisciplinary approaches	0.669	0.585	
	Q	Overseas issues	0.589	0.438	
	R	Referencing System	0.552	0.852	
	S	Data management	0.114	0.571	
	T	Protocol or Study Design	0.6	0.664	
	U	Research report	0.226	0.49	
	V	Publication	0.344	0.502	
Career	A	Qualitative Analysis	0.555	0.827	
	B	Quantitative Analysis	0.228	0.409	
	C	Apply funding	0.418	0.737	
	D	Data collection	0.439	0.269	
	E	Review literature	0.108	0.176	
	F	Questionnaires	0.502	0.895	
	G	Finding literature	0.015	0.0555	More early career (up to PhD student) scored themselves lower on this
	H	Manage a project	0.263	0.997	

	I	Networking	0.928	0.191	
	J	Present research	0.813	0.961	
	K	Provide advice	0.175	0.413	
	L	Secure grants	0.077	0.141	
	M	Health and Safety	0.201	0.409	
	N	Ethics	0.695	0.295	
	O	Finance claims	0.283	0.994	
	P	Interdisciplinary approach…	0.535	0.872	
	Q	Overseas issues	0.257	0.398	
	R	Referencing System	0.165	0.0575	
	S	Data management	0.266	0.937	
	T	Protocol or Study Design	0.866	0.965	
	U	Research report	0.172	0.407	
	V	Publication	0.037	0.64	More early career (up to PhD student) scored themselves lower on this
Contract	A	Qualitative Analysis	0.894	0.732	
	B	Quantitative Analysis	0.961	0.298	
	C	Apply funding	0.365	0.295	
	D	Data collection	0.954	0.148	
	E	Review literature	0.36	1	
	F	Questionnaires	0.819	0.582	
	G	Finding literature	0.0755	0.557	
	H	Manage a project	0.32	1	
	I	Networking	0.143	0.37	
	J	Present research	0.402	0.363	
	K	Provide advice	0.717	1	
	L	Secure grants	0.752	0.334	
	M	Health and Safety	0.193	0.356	
	N	Ethics	0.871	0.295	
	O	Finance claims	0.199	0.405	
	P	Interdisciplinary approaches	0.193	0.42	
	Q	Overseas issues	0.344	1	
	R	Referencing System	0.848	0.106	
	S	Data management	0.622	0.411	
	T	Protocol or Study Design	0.957	0.536	
	U	Research report	0.589	0.649	
	V	Publication	0.899	0.822	
Gender	A	Qualitative Analysis	0.226	0.289	
	B	Quantitative Analysis	0.000709	0.135	Most males and females scored themselves mode-high on this but some females scored themselves very low on this
	C	Apply funding	0.408	0.598	
	D	Data collection	0.294	0.282	
	E	Review literature	0.523	0.11	
	F	Questionnaires	0.328	0.215	
	G	Finding literature	0.85	0.214	
	H	Manage a project	0.552	0.957	
	I	Networking	0.731	0.233	
	J	Present research	0.589	0.654	
	K	Provide advice	0.757	0.431	
	L	Secure grants	0.896	0.339	
	M	Health and Safety	0.338	0.509	
	N	Ethics	0.824	0.768	
	O	Finance claims	0.868	0.135	
	P	Interdisciplinary approaches	0.854	0.11	
	Q	Overseas issues	0.0916	0.359	
	R	Referencing System	0.217	0.718	
	S	Data management	0.416	0.221	
	T	Protocol or Study Design	0.755	0.24	

	U	Research report	0.864	0.485	
	V	Publication	0.153	0.633	
Region	A	Qualitative Analysis	0.523	0.0205	SE Asia researchers indicated higher improvement, while UK researchers indicated no change or lower degree of improvement
	B	Quantitative Analysis	0.351	0.0275	
	C	Apply funding	0.371	0.229	
	D	Data collection	0.0735	0.0005	SE Asia researchers indicated higher improvement, while UK researchers indicated no change or lower degree of improvement
	E	Review literature	0.688	0.0005	
	F	Questionnaires	0.56	0.0005	
	G	Finding literature	0.87	0.0005	
	H	Manage a project	0.085	0.0175	
	I	Networking	0.244	0.0005	
	J	Present research	0.446	0.008	
	K	Provide advice	0.955	0.38	
	L	Secure grants	0.605	0.301	
	M	Health and Safety	0.09	0.514	
	N	Ethics	0.899	0.124	
	O	Finance claims	0.356	0.135	
	P	Interdisciplinary approaches	0.531	0.001	SE Asia researchers indicated higher improvement, while UK researchers indicated no change or lower degree of improvement
	Q	Overseas issues	0.444	0.848	
	R	Referencing System	0.287	0.001	SE Asia researchers indicated higher improvement, while UK researchers indicated no change or lower degree of improvement
	S	Data management	0.687	0.0265	
	T	Protocol or Study Design	0.525	0.0825	
	U	Research report	0.887	0.0015	SE Asia researchers indicated higher improvement, while UK researchers indicated no change or lower degree of improvement
	V	Publication	0.818	0.008	

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939 **Table S6** Codes and full description of aspect of research capacity associated with Figure 7 in the
940 main text

Letter code given in Figure	Full Research Capacity Aspect associated with code
A	Analysing qualitative research data
B	Analysing quantitative research data
C	Applying for research funding/writing research grants
D	Collecting data e.g. surveys, interviews
E	Critically reviewing the literature
F	Designing questionnaires
G	Finding relevant literature
H	Managing a project
I	Networking
J	Presenting research findings
K	Providing advice to less experienced researchers
L	Securing research funding
M	Submitting a health and safety assessment
N	Submitting an ethics application
O	Submitting financial claims from a research grant
P	Understanding interdisciplinary approaches and issues
Q	Understanding overseas issues and challenges
R	Using a computer referencing system (e.g. Endnote)
S	Using computer data management systems
T	Writing a research protocol or designing a study
U	Writing a research report

V	Writing for publication in peer-reviewed journals

Table S7 Associations between team level questions (linked to Figure 8 in the main text) with demographic variables based on Fisher exact test

Demographic	Letter Code	Skill	Success Level Fisher Exact Test P value	Improvement Level Fisher Exact Test P value	Notes
Age	A	Impactful research	0.978	0.886	
	B	Disseminates research	0.997	0.658	
	C	Planning with evidence	0.993	0.619	
	D	Team level planning	0.958	0.817	
	E	Staff involved in plans	0.99	0.82	
	F	Data management	0.921	0.5	
	G	Ethics	0.664	0.445	
	H	Finance management	0.894	0.356	
	I	Health and Safety	0.942	0.191	
	J	Staff training	0.183	0.867	
	K	Expert advice	0.913	0.896	
	L	External partners	0.911	0.922	
	M	Funds, equipment, admin	0.831	0.541	
	N	Mentoring	0.706	0.945	
	O	Research quality	0.986	0.359	
	P	Software	0.974	0.138	
	Q	Leaders support research	0.931	0.799	
	R	Research opportunities	0.95	0.36	
	S	Interdisciplinary approach	0.957	0.503	
	T	Scholarships	0.1	0.872	
	U	Publication	0.339	0.45	
Career	A	Impactful research	0.733	0.995	
	B	Disseminates research	0.044	0.978	Early career, students and less than 5 years post PhD scored their teams highly on this
	C	Planning with evidence	0.418	0.276	
	D	Team level planning	0.586	0.753	
	E	Staff involved in plans	0.7	0.826	
	F	Data management	0.696	0.838	
	G	Ethics	0.104	0.214	
	H	Finance management	0.305	0.695	
	I	Health and Safety	0.623	0.333	
	J	Staff training	0.818	0.888	
	K	Expert advice	0.01	0.53	PhD students scored their teams lower on this

	L	External partners	0.722	0.648	
	M	Funds, equipment, admin	0.431	0.88	
	N	Mentoring	0.283	0.42	
	O	Research quality	0.128	0.821	
	P	Software	0.007	0.352	More experienced researchers scored their teams higher on this than early and mid-career researchers
	Q	Leaders support research	0.346	0.747	
	R	Research opportunities	0.0535	0.808	
	S	Interdisciplinary approach	0.293	0.876	
	T	Scholarships	0.041	0.665	Some early career groups - PhD students and up to 5 years post PhD - scored their teams lower on this than other groups
	U	Publication	0.388	0.18	
Contract	A	Impactful research	0.386	0.798	
	B	Disseminates research	0.187	0.551	
	C	Planning with evidence	0.647	0.766	
	D	Team level planning	0.592	0.798	
	E	Staff involved in plans	0.494	0.699	
	F	Data management	0.063	0.94	
	G	Ethics	0.946	0.42	
	H	Finance management	0.801	0.724	
	I	Health and Safety	0.544	0.191	
	J	Staff training	0.886	0.564	
	K	Expert advice	0.873	0.683	
	L	External partners	0.98	1	
	M	Funds, equipment, admin	0.539	0.93	
	N	Mentoring	0.107	0.1	
	O	Research quality	0.703	0.933	
	P	Software	0.0345	0.619	Some of those on fixed term contracts scored their teams lower than those on permanent contracts
	Q	Leaders support research	0.567	0.929	
	R	Research opportunities	0.733	0.487	
	S	Interdisciplinary approach	0.129	0.742	
	T	Scholarships	0.92	1	
	U	Publication	0.522	0.938	
Gender	A	Impactful research	0.905	0.588	
	B	Disseminates research	0.715	0.549	
	C	Planning with evidence	0.622	0.358	
	D	Team level planning	0.685	0.403	

	E	Staff involved in plans	0.547	0.606	
	F	Data management	0.448	0.684	
	G	Ethics	0.101	0.209	
	H	Finance management	0.279	0.271	
	I	Health and Safety	0.078	0.87	
	J	Staff training	0.902	0.711	
	K	Expert advice	0.608	0.108	
	L	External partners	0.025	0.916	More male researchers scored their teams lower on this
	M	Funds, equipment, admin	0.458	0.518	
	N	Mentoring	0.284	0.354	
	O	Research quality	0.842	0.904	
	P	Software	0.171	0.72	
	Q	Leaders support research	0.465	0.839	
	R	Research opportunities	0.917	0.554	
	S	Interdisciplinary approach	0.686	0.267	
	T	Scholarships	0.297	0.188	
	U	Publication	0.074	0.588	
Region	A	Impactful research	0.519	0.024	SE Asia researchers indicated higher improvement, while UK researchers indicated no change or lower degree of improvement
	B	Disseminates research	0.199	0.001	
	C	Planning with evidence	0.932	0.0025	
	D	Team level planning	0.663	0.0005	
	E	Staff involved in plans	0.102	0.001	
	F	Data management	0.84	0.0005	
	G	Ethics	0.71	0.0005	
	H	Finance management	0.629	0.0005	
	I	Health and Safety	0.651	0.0005	
	J	Staff training	0.375	0.003	
	K	Expert advice	0.527	0.0005	
	L	External partners	0.1	0.0005	
	M	Funds, equipment, admin	0.438	0.0005	
	N	Mentoring	0.765	0.02	
	O	Research quality	0.817	0.0085	
	P	Software	0.486	0.004	
	Q	Leaders support research	0.29	0.001	
	R	Research opportunities	0.261	0.0005	
	S	Interdisciplinary approach	0.239	0.0005	
	T	Scholarships	0.503	0.07	
	U	Publication	0.365	0.0005	SE Asia researchers indicated higher improvement, while UK researchers indicated no change or lower degree of improvement

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946 **Table S8** Codes and full description of aspect of research capacity associated with Figure 8 in the
947 main text

Letter code given in Figure	Full Research Capacity Aspect associated with code
A	Conducts research activities relevant to creating impact (e.g. making a difference to society, SDGs, local communities, policies, management, etc.)
B	Disseminates research results at research forums/seminars
C	Does planning that is guided by evidence
D	Does team level planning for research development
E	Ensures staff involvement in developing that plan
F	Has adequate data management support and planning
G	Has adequate ethics support and planning
H	Has adequate finance management support and planning
I	Has adequate health and safety support and planning
J	Has adequate resources to support staff research training
K	Has experts accessible for research advice
L	Has external partners (e.g. government agencies, communities, public) engaged in research activities/planning
M	Has funds, equipment or admin to support research activities
N	Has incentives and support for mentoring activities
O	Has mechanisms to monitor research quality
P	Has software available to support research activities
Q	Has team leaders that support research
R	Provides opportunities to get involved in research
S	Supports an interdisciplinary approach to research
T	Supports applications for research scholarships/degrees
U	Supports the peer-reviewed publication of research

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949 **Table S9** Associations between institution level questions (linked to Figure 9 in the main text) with
950 demographic variables based on Fisher exact test

Demographic	Letter Code	Skill	Success Level Fisher Exact Test P value	Improvement Level Fisher Exact Test P value	Notes
Age	A	External funding	0.893	0.537	
	B	Impactful research	0.501	0.699	
	C	External partners	0.188	0.112	
	D	Planning with evidence	0.139	0.95	
	E	Career pathways	0.382	0.683	
	F	Research development policy	0.861	0.582	
	G	Data management	0.565	0.212	
	H	Ethics	0.667	0.979	
	I	Finance management	0.863	0.29	
	J	Health and Safety	0.396	0.962	
	K	Staff training	0.99	0.976	
	L	Experts	0.96	0.322	
	M	Funds, equipment, admin	0.911	0.728	
	N	Research quality	0.698	0.27	
	O	Dissemination	0.755	0.898	
	P	Leaders support research	0.335	0.825	
	Q	Software	0.642	0.386	
	R	Scholarships	0.627	0.954	
	S	Interdisciplinary approach	0.584	0.713	
	T	Publication	0.453	0.612	
Career	A	External funding	0.046	0.485	Early-mid (post MSc up to 15 years post PhD) level were more likely to score their institution lower on this
	B	Impactful research	0.853	0.455	

	C	External partners	0.0735	0.194	
	D	Planning with evidence	0.285	0.372	
	E	Career pathways	0.179	0.453	
	F	Research development policy	0.578	0.938	
	G	Data management	0.551	0.855	
	H	Ethics	0.0875	0.498	
	I	Finance management	0.214	0.433	
	J	Health and Safety	0.186	0.236	
	K	Staff training	0.199	0.366	
	L	Experts	0.255	0.278	
	M	Funds, equipment, admin	0.693	0.451	
	N	Research quality	0.28	0.722	
	O	Dissemination	0.116	0.533	
	P	Leaders support research	0.702	0.298	
	Q	Software	0.011	0.09	Later career (more than 15 years post PhD) were more likely to score their institution higher on this
	R	Scholarships	0.236	0.428	
	S	Interdisciplinary approach	0.0415	0.772	Later career (more than 15 years post PhD) were more likely to score their institution higher on this
	T	Publication	0.198	0.688	
Contract	A	External funding	0.672	0.626	
	B	Impactful research	0.807	0.7	
	C	External partners	0.964	0.969	
	D	Planning with evidence	0.185	0.834	
	E	Career pathways	0.233	0.417	
	F	Research development policy	0.3	0.681	
	G	Data management	0.749	0.717	
	H	Ethics	0.864	0.77	
	I	Finance management	0.923	0.717	
	J	Health and Safety	0.986	0.435	
	K	Staff training	0.701	1	
	L	Experts	0.372	0.897	
	M	Funds, equipment, admin	0.387	0.929	
	N	Research quality	0.838	0.294	
	O	Dissemination	0.541	0.936	
	P	Leaders support research	0.847	0.676	
	Q	Software	0.14	0.237	
	R	Scholarships	0.908	0.454	
	S	Interdisciplinary approach	0.933	0.628	
	T	Publication	0.29	1	
Gender	A	External funding	0.63	0.683	
	B	Impactful research	0.298	0.1	
	C	External partners	0.65	0.313	
	D	Planning with evidence	0.449	0.154	
	E	Career pathways	0.553	0.0865	
	F	Research development policy	0.765	0.0065	Females were more likely to report no improvement on this aspect in their institution
	G	Data management	0.446	0.115	
	H	Ethics	0.981	0.0055	Females were more likely to report no improvement on this aspect in their institution
	I	Finance management	0.597	0.408	
	J	Health and Safety	0.78	0.558	
	K	Staff training	0.976	0.229	
	L	Experts	0.796	0.407	
	M	Funds, equipment, admin	0.822	0.393	
	N	Research quality	0.928	0.479	
	O	Dissemination	0.974	0.854	
	P	Leaders support research	0.971	0.42	
	Q	Software	0.624	0.796	
	R	Scholarships	0.999	0.329	
	S	Interdisciplinary approach	0.59	0.595	
	T	Publication	0.503	0.639	
Region	A	External funding	0.931	0.001	SE Asia researchers indicated higher
	B	Impactful research	0.879	0.003	improvement, while UK researchers

	C	External partners	0.905	0.002	indicated no change or lower degree of improvement
	D	Planning with evidence	0.96	0.0005	
	E	Career pathways	0.762	0.0005	
	F	Research development policy	0.932	0.0005	
	G	Data management	0.988	0.0005	
	H	Ethics	0.501	0.0005	
	I	Finance management	0.972	0.0005	
	J	Health and Safety	0.695	0.0005	
	K	Staff training	0.0495	0.0005	UK researchers were more likely to score a high score (above 7) for their institutions on this. Several SE Asian researchers scored their institutions mid (5-7) on this, though some also scored gave the highest score. SE Asia researchers indicated higher improvement, while UK researchers indicated no change or lower degree of improvement
	L	Experts	0.952	0.0015	SE Asia researchers indicated higher improvement, while UK researchers indicated no change or lower degree of improvement
	M	Funds, equipment, admin	0.313	0.0005	
	N	Research quality	1	0.001	
	O	Dissemination	0.886	0.0075	
	P	Leaders support research	0.384	0.0005	
	Q	Software	0.806	0.0125	
	R	Scholarships	1	0.001	
	S	Interdisciplinary approach	0.744	0.002	
	T	Publication	0.888	0.0005	

Table S10 Codes and full description of aspect of research capacity associated with Figure 9 in the main text

Letter code given in Figure	Full Research Capacity Aspect associated with code
A	Access external funding for research
B	Encourages research activities relevant to creating impact (e.g. making a difference to society, SDGs, local communities, policies, management, etc.)
C	Engages external partners (e.g. government agencies, communities, public) in research activities/planning
D	Ensures organisational planning is guided by evidence
E	Ensures staff career pathways are available in research
F	Has a plan or policy for research development
G	Has adequate data management support and planning
H	Has adequate ethics support and planning
I	Has adequate finance management support and planning
J	Has adequate health and safety support and planning
K	Has adequate resource to support staff research training
L	Has experts accessible for research advice
M	Has funds, equipment or admin to support research activities
N	Has mechanisms to monitor research quality
O	Has regular forums/bulletins to present research findings
P	Has senior managers that support research
Q	Has software programs for analysing research data
R	Supports applications for research scholarship/degrees
S	Supports interdisciplinary approaches to research
T	Supports the peer-reviewed publication of research

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References

BARRETT, A. M., CROSSLEY, M. & DACHI, H. A. 2011. International collaboration and research capacity building: learning from the EdQual experience. *Comparative Education,* 47**,** 25-43.

BIERMANN, F., KANIE, N. & KIM, R. E. 2017. Global governance by goal-setting: the novel approach of the UN Sustainable Development Goals. *Current Opinion in Environmental Sustainability,* 26-27**,** 26-31.

CHEUNG, V. V., BELL, A., CREENCIA, L. A., FLEMING, L. E., GOH, H. C., MAHARJA, C., MORRISSEY, K., RICHTER, I., THEN, A. Y. & AUSTEN, M. C. 2021. Blue Communities in Southeast Asia. *Environmental Scientist,* 30**,** 96-102.

CHU, K. M., JAYARAMAN, S., KYAMANYWA, P. & NTAKIYIRUTA, G. 2014. Building Research Capacity in Africa: Equity and Global Health Collaborations. *PLOS Medicine,* 11**,** e1001612.

DANGLES, O., LOIRAT, J., FREOUR, C., SERRE, S., VACHER, J. & LE ROUX, X. 2016. Research on Biodiversity and Climate Change at a Distance: Collaboration Networks between Europe and Latin America and the Caribbean. *PLOS ONE,* 11**,** e0157441.

FAM, D., CLARKE, E., FREETH, R., DERWORT, P., KLANIECKI, K., KATER-WETTSTÄDT, L., JUAREZ-BOURKE, S., HILSER, S., PEUKERT, D., MEYER, E. & HORCEA-MILCU, A.-I. 2020. Interdisciplinary and transdisciplinary research and practice: Balancing expectations of the 'old' academy with the future model of universities as 'problem solvers'. *Higher Education Quarterly,* 74**,** 19-34.

FRANSMAN, J., HALL, B., HAYMAN, R., NARAYANAN, P., NEWMAN, K. & TANDON, R. 2021. Beyond partnerships: embracing complexity to understand and improve research collaboration for global development. *Canadian Journal of Development Studies / Revue canadienne d'études du développement,* 42**,** 326-346.

GRIEVE, T. & MITCHELL, R. 2020. Promoting Meaningful and Equitable Relationships? Exploring the UK's Global Challenges Research Fund (GCRF) Funding Criteria from the Perspectives of African Partners. *The European Journal of Development Research,* 32**,** 514-528.

GUIMARÃES, M. H., POHL, C., BINA, O. & VARANDA, M. 2019. Who is doing inter- and transdisciplinary research, and why? An empirical study of motivations, attitudes, skills, and behaviours. *Futures,* 112**,** 102441.

HAMMAD, W. & AL-ANI, W. 2021. Building Educational Research Capacity: Challenges and Opportunities From the Perspectives of Faculty Members at a National University in Oman. *SAGE Open,* 11**,** 21582440211032668.

HARVEY, B., HUANG, Y.-S., ARAUJO, J., VINCENT, K. & SABIITI, G. 2022. Breaking vicious cycles? A systems perspective on Southern leadership in climate and development research programmes. *Climate and Development***,** 1-12.

HATTAM, C., BROSZEIT, S., LANGMEAD, O., PRAPTIWI, R. A., CHING LIM, V., CREENCIA, L. A., DUC HAU, T., MAHARJA, C., WULANDARI, P., MITRA SETIA, T., SUGARDJITO, J., JAVIER, J., JOSE, E., JANINE GAJARDO, L., YEE-HUI THEN, A., YANG AMRI, A., JOHARI, S., VIVIAN JUSTINE, E., ALI SYED HUSSEIN, M., CHING GOH, H., PHUC HUNG, N., VAN QUYEN, N., NGOC THAO, L., HOANG TRI, N., EDWARDS-JONES, A., CLEWLEY, D. & AUSTEN, M. 2021. A matrix approach to tropical marine ecosystem service assessments in South east Asia. *Ecosystem Services,* 51**,** 101346.

HEWITSON, B. 2015. To build capacity, build confidence. *Nature Geoscience,* 8**,** 497-499.

HOANG, C. H. 2021. Glocal production of knowledge: exploring Vietnamese scholars' perception of 'good' research. *Compare: A Journal of Comparative and International Education***,** 1-19.

HOLDEN, L., PAGER, S., GOLENKO, X. & WARE, R. S. 2012. Validation of the research capacity and culture (RCC) tool: measuring RCC at individual, team and organisation levels. *Aust J Prim Health,* 18**,** 62-7.

IPCC 2018. Global warming of 1.5°C. An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse Gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. . IPCC.

KARLSSON, S., SREBOTNJAK, T. & GONZALES, P. 2007. Understanding the North–South knowledge divide and its implications for policy: a quantitative analysis of the generation of scientific knowledge in the environmental sciences. *Environmental Science & Policy,* 10**,** 668-684.

MCCLURE, A. 2020. Inclusive, participatory and reflexive learning processes for climate resilience: key lessons from FRACTAL. FRACTAL working paper #9.

NAGENDRA, H. 2018. The global south is rich in sustainability lessons that students deserve to hear. *Nature,* 557**,** 485-488.

NGUYEN, P. T., DUONG, M. L. & EALES, J. 2020. What is the influence on socio-economic well-being of UNESCO biosphere reserves in Southeast Asia? A systematic review protocol. . Zenodo.

RADINGER-PEER, V., SCHAUPPENLEHNER-KLOYBER, E., PENKER, M. & GUGERELL, K. 2022. Different perspectives on a common goal? The Q-method as a formative assessment to elucidate varying expectations towards transdisciplinary research collaborations. *Sustainability Science*.

RICHTER, I., GABE-THOMAS, E., MAHARJA, C., NGUYEN, T. H., VAN NGUYEN, Q., PRAPTIWI, R. & PAHL, S. 2021. Virtual Capacity Building for International Research Collaborations in Times of COVID-19 and #Flygskam. *Frontiers in Communication,* 5.

SCHUCAN BIRD, K. & PITMAN, L. 2020. How diverse is your reading list? Exploring issues of representation and decolonisation in the UK. *Higher Education,* 79**,** 903-920.

STEELMAN, T., BOGDAN, A., MANTYKA-PRINGLE, C., BRADFORD, L., REED, M. G., BAINES, S., FRESQUE-BAXTER, J., JARDINE, T., SHANTZ, S., ABU, R., STAPLES, K., ANDREWS, E., BHARADWAJ, L., STRICKERT, G., JONES, P., LINDENSCHMIDT, K., POELZER, G. & THE DELTA DIALOGUE, N. 2021. Evaluating transdisciplinary research practices: insights from social network analysis. *Sustainability Science,* 16**,** 631-645.

UN 2015. United Nations General Assembly: Transforming Our World: The 2030 Agenda for Sustainable Development. Draft resolution referred to the United Nations summit for the

adoption of the post-2015 development agenda by the General Assembly at its sixty-ninth session. UN Doc. A/70/L.1 of 18 September 2015.

UNEP 2002. Capacity Building for Sustainable Development: an overview of UNEP environmental capacity development initiatives. .

UOL 2021. University of Liverpool (UoL) Our Strategy 2026. Liverpool, UK: University of Liverpool.

VALLEJO, B. & WEHN, U. 2016. Capacity Development Evaluation: The Challenge of the Results Agenda and Measuring Return on Investment in the Global South. *World Development,* 79**,** 1-13.

WOODHILL, J. 2010. Capacities for Institutional Innovation: A Complexity Perspective. *IDS Bulletin,* 41**,** 47-59.

ZAIN, M. A., SUHAIMI, J., DAHLUI, M., GOH, H. C., THEN, A. Y.-H., YAKUB, N. A., NOOR, M. I. M., GARSIDE, R., EALES, J., JOSE, E. & KARI, F. 2022. What are the outcomes of marine site protection on poverty of coastal communities in Southeast Asia? A systematic review protocol. *Environmental Evidence,* 11**,** 2.

Wickham (2009) ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag, New York.

R Development Core Team (2016) R: A language and environment for statistical computing. R Foundation for Statistical Computing,Vienna, Austria. https://www.R-project.org/ (2016)