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Dear Editor,

Please consider the paper titled '*Growing interdisciplinary research capacity for sustainable development: Self-reported evaluation'* for publication in *UCL Open Environment*.

The assessment presented in this work is of the personal perspectives of 56 researchers who took part in the international, interdisciplinary Blue Communities project. Researchers at all career stages came from the UK and four Southeast Asian countries, Malaysia, Vietnam, Indonesia and Philippines. One of the main goals of the project was to build mutual research capacity across research participants towards meeting the UN Sustainable Development Goals and addressing challenges related to wellbeing, livelihoods and food security for coastal communities in the Southeast Asian countries. The approach used resulted in quantitative data from a diverse group of researchers on the impact of the research capacity building activity in this project, which had taken the specific approach of 'learning-by-doing' as well as other training activities to strengthen capacity.

A central part of achieving sustainability is through building research capacity of researchers and communities where global challenges are most felt. There is currently a drive in high income countries to carry out globally connected research that solves global issues and builds capacity in communities and researchers from low income countries. However, approaches have had mixed results, with researchers from low income countries sometimes feeling marginalised in the research process. This paper addresses the need to share good practice and lessons learnt in building research capacity in these types of projects, with the research community engaging in them, and to make researchers aware of the types of issues that can arise so that projects can be effective, fair, and inclusive. This is key to achieving sustainability.

The results presented here provide a broader perspective on the success of the learning-by-doing strategy than focussing on research outputs such as publications and funding alone. The study has identified strengths and gaps in capacity building and discussed possible drivers of these. This learning can be used to enhance or modify approaches used for capacity building in future international collaborations that aim to improve sustainability through reaching researchers likely to be involved in these collaborations. This is, therefore, why this work is a good fit for *UCL Open Environment*. Publishing in this journal is also relevant to reach the broader research community who are engaged in sustainability activities, as researchers involved in these inter- and trans-disciplinary projects tend to come from varied disciplines including environmental sciences, medicine, clean energy, social sciences, and economics.

Yours faithfully,

Fiona Culhane

35 ## Title

36 Growing interdisciplinary research capacity for sustainable development: Self-reported evaluation

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40 ## Abstract

41 Global challenges such as climate change, food security and human health and wellbeing

42 disproportionately impact people from low-income countries. These challenges are complex and

43 require an international and transdisciplinary approach to research, with research skills and

44 expertise from different disciplines, sectors, and regions. In addressing this, a key goal of an official

45 development assistance funded research project, Blue Communities, was to create and expand

46 mutual interdisciplinary capacity of both United Kingdom and Southeast Asian Partners. An online

47 survey was distributed to the participants of the Blue Communities project comprising researchers

48 across all career stages. Participants were asked about their perceptions of the research capacity

49 and culture of their organisation, team and self and whether they believed any aspects have

50 changed since involvement with the project. Results were mainly positive across all aspects of

51 research capacity but in particular from Southeast Asian respondents. The conflict between

52 achieving research aims, building research capacity and making societal impact was evident.

53 Institutional support is required to value these core aspects of interdisciplinary research.

54

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

56 environmental sustainability

57

1. Introduction

58

59 Global challenges such as climate change, food security and human health and wellbeing

60 disproportionately impact people from low-income countries (IPCC, 2018) and are addressed

61 through global governance with the United Nations Sustainable Development Goals (UN, 2015,

62 Biermann et al., 2017). It is increasingly recognised in the research community, by research funders

63 (e.g. the UK's Global Challenges Research Fund) and by institutions (e.g. the University of Liverpool's

64 2026 strategy (UoL, 2021)) that these challenges are complex and require an international and

65 interdisciplinary approach to research, integrating research skills and expertise from different

66 disciplines, sectors and regions (Fransman et al., 2021, Dangles et al., 2016). Building sustainable

67 capacity in research communities is required to address these global challenges (Fransman et al.,

68 2021). With finance and research agendas dominated by the Global North (Barrett et al., 2011,

69 Karlsson et al., 2007), research capacity is recognised to be unevenly distributed and often limited in

70 the regions where global challenges are most felt (Harvey et al., 2022). Research programmes aimed

71 at addressing global challenges therefore increasingly try to embed research capacity strengthening

72 (Harvey et al., 2022). Capacity building must strengthen the resilience of the individual and/or

73 organisation, thereby ensuring their longer-term sustainability (Woodhill, 2010) to address complex

74 global challenges.

75 The often uneven coverage of global challenges research between high- and low-income countries is

76 exemplified by ecosystem service research, a key link between ecosystems and human wellbeing,

77 which is lacking in Southeast (SE) Asian countries (Hattam et al. (2021). Collaboration between high

78 income countries (HIC) and low income countries (LIC) has been suggested as a way to increase

79 research capacity across all partners and to fill such research gaps (Hammad and Al-Ani, 2021, UNEP,

80 2002). However, studies have shown that research capacity building in such collaborations can be

81 limited, for example publications are often led by authors in HIC (Dangles et al., 2016, Harvey et al.,

82 2022). Nevertheless, it should also be noted that outputs of research publications and research

83 funding, driven largely by the funders and the research culture in HICs, are not the only indication of

84   research capacity (Chu et al., 2014, Hewitson, 2015). Achieving these research products, can be in

85   conflict with building research capacity (Barrett et al., 2011, Harvey et al., 2022). In addition, the UK

86   perception of 'good' research may contrast with perceptions of those in other cultures (Hoang,

87   2021). Harvey et al. (2022) argue that significant disruption of the current system is required to truly

88   achieve balanced research capacity.

89   The Blue Communities interdisciplinary research and capacity building project recognised that

90   marine and coastal ecosystems are essential for food security, livelihoods, health and well-being

91   through direct human activities such as fisheries and tourism, and for regulating and supporting

92   services like climate regulation; and that global loss of biodiversity and ecosystem services should be

93   addressed through an integrated approach (Cheung et al., 2021 https://www.blue-

94   communities.org/). Blue Communities was a four-year project, funded by the UK's Global Challenges

95   Research Fund (GCRF), that aimed to build capacity for sustainable interactions with marine

96   ecosystems for health, well-being, food security and livelihoods. The primary objectives were to:

97   1. Develop collaborative interdisciplinary research to improve the integrated management of

98   marine and coastal environments to reduce conflict between users, mitigate risks associated

99   with expanded or new uses, and protect fragile ecosystems while supporting livelihoods,

100   food security, health and well-being of coastal communities.

101   2. Create and expand mutual interdisciplinary capacity and capability building of both UK and

102   SE Asian Partners and the study communities in integrated planning through sustainable

103   interactions with marine ecosystems for the health, well-being, food and livelihoods of

104   coastal communities.

105

106   The GCRF sought to achieve '*meaningful and equitable relationships*' (Grieve and Mitchell, 2020)

107   through the goal of building research capacity across partners involved in the project. In the Blue

108   Communities project, *"a 'learn by doing' approach, where SE Asian researchers were encouraged to*

109   *lead their research studies and seek support from experienced UK researchers when needed"* was

110   taken (Blue Communities Handbook). Throughout the project, Blue Communities activities (e.g. skills

111   workshops, paper writing, seminars, mentorship, flexible communication, networking, formation of

112   research ethics and health and safety committees, etc.) have allowed the building of research

113   capacity, while achieving research objectives. The project also formed an Early Career Researcher

114   network and encouraged Early Career Researchers to develop their own funding calls, proposals, and

115   apply for additional funding to support these.

116

117   The success of this approach can be evaluated by looking at the research products, however, this will

118   only capture the current research outputs and not the sustainable future research capacity that has

119   been built through the project. By taking a broader perspective on research capacity from a diverse

120   group of researchers and allowing researchers involved in the project to have an opportunity to

121   formally reflect on and report their perceptions of how research capacity has improved through

122   involvement with the project, we are able to gain a fuller understanding of research capacity within

123   the group. This learning can be used to enhance or modify approaches used for capacity building in

124   future collaborations.

125   The aims of this paper are to:

126   - evaluate the perceptions of the current research capacity of the organisations,

127   research teams and individuals involved in the Blue Communities (BC) project and

128   identify potential strengths and gaps

129   - evaluate the perceptions of the change in the research capacity of the organisations,

130   research teams and individuals attributed to involvement in Blue Communities, and

131   link this to the approach used by the Blue Communities (BC) research programme

132   - explore demographic factors, specifically region and career stage, that may influence

133   these perceptions

| 134 | •   evaluate the successes and challenges for growing current and future research |
| 135 | capacity for sustainable development |

136

2. Methods

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2.1 Questionnaire

140 An online survey was distributed to the participants of the Blue Communities project. Participants

141 were from academic institutions and non-governmental organisations in the UK and academic

142 institutions in four Southeast (SE) Asian countries – Malaysia, Philippines, Indonesia and Vietnam.

143 Researchers across all career stages were included. The timing of the distribution of the survey

144 coincided with the final two months of the four-year Blue Communities grant and therefore

145 captured perceptions at this point in time. The questionnaire was based on a modified Research

146 Capacity and Culture Tool (Holden et al., 2012) that gathers information on participant's perceptions

147 of the research capacity and culture of their institution, team and self. The survey was written in the

148 English language and consisted of questions in four parts: (1) demography, (2) individual research

149 capacity, (3) team level research capacity (participant's Blue Communities team at their own

150 institution) and (4) institution level research capacity. Questions included those with a numeric scale

151 response to rate skills on various aspects related to research capacity and rating scale responses to

152 assess change in research capacity. See Supplementary Material for full survey.

2.2 Data analysis

154 To explore overall perceptions of research capacity and whether these differed between groups

155 based on region (Global South and Global North), quantitative data were summarised based on the

156 country of participant, or UK (/European) vs SE Asian. In addition, perceptions by career stage of

157 participant were explored for the most relevant questions (research motivators, barriers and what

158 people valued from the BC project).

159   To compare across unequal groups of responses to questions on what activities people participated

160   in, what resources they benefited from, what are their motivators and barriers to carrying out

161   research, and what they valued most from the project, responses were weighted according to the

162   total number of individuals per group. That is, the frequency of responses is shown as the proportion

163   of participants in a group who responded. These are presented as bar plots.

164   The responses to a number of statements regarding participants' experience in the project and the

165   current research capacity and perceived improvement in capacity is visualised in side-by-side matrix

166   plots where the size and colour of squares represent the frequency of responses against each score

167   to each aspect of research capacity for UK (and other European) and SE Asian respondents. Matrix

168   plots were produced using Raw Graphs 2.0 (https://rawgraphs.io/).

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170   ## 3. Results

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172   *3.1 Demographic information*

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174   A total of 56 people responded to the survey, out of approximately 115 researchers who have been

175   involved over various time periods throughout the project. Of these, most (57%) were female and

176   aged between 31-50 (64%) (Table 1). The largest group of respondents came from the UK (or other

177   European countries) and the smallest from Indonesia.

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

Demographic variable	Category	Response Rate (%)
Gender	*Female*	57
	Male	41
	Prefer not to say	2
Age range	*18-30*	16
	31-50	64
	51-64	14
	65+	4
	Prefer not to say	2
Country of Institution	*Indonesia*	7
	Malaysia	20
	Philippines	23
	UK (and other European)	33
	Vietnam	18

183

184 Most respondents to the survey came from academia (88%), though NGOs and others were also

185 represented (Table 2). Most researchers have fixed term contracts and have multiple work

186 commitments. All career stages from early, mid, and later career were represented in the survey,

187 though most came from the broader early career categories (students and PhD + five years or less

188 experience).

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

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

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201 *3.2 Individual Research Capacity*

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203 Respondents took part in a broad range of activities throughout the project, with most people

204 involved in publishing, presenting, analysing quantitative data, collecting data and designing studies

205 (Figure 1). Of the top five activities, there was fairly even distribution in involvement across

206 countries/regions in terms of designing a study ('Writing a research protocol or designing a study'),

207 analysing ('Analysing quantitative research data'), interpreting and disseminating the results

208 ('Writing a research report, presentation or paper for publication'; 'Co-authoring a paper for

209 publication'), but collecting the data ('Collecting data e.g. surveys, interviews') was mostly carried

210 out by SE Asian respondents. Fewer people overall were involved with applying for and securing

211 research funding, submitting financial claims, and submitting health and safety assessments.

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. Percentage value given at the end of each bar is the total response rate (e.g. 100% would represent that all this question's respondents chose that option), while 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).

Respondents across all regions benefitted the most from knowledge exchange resources such as seminars, networking, training, access to expertise and mentorship (Figure 2). Resources such as protocol development, library access, health and safety guidance, database management and software benefitted fewer respondents overall, but of those, benefits were felt mostly by the SE Asian respondents.
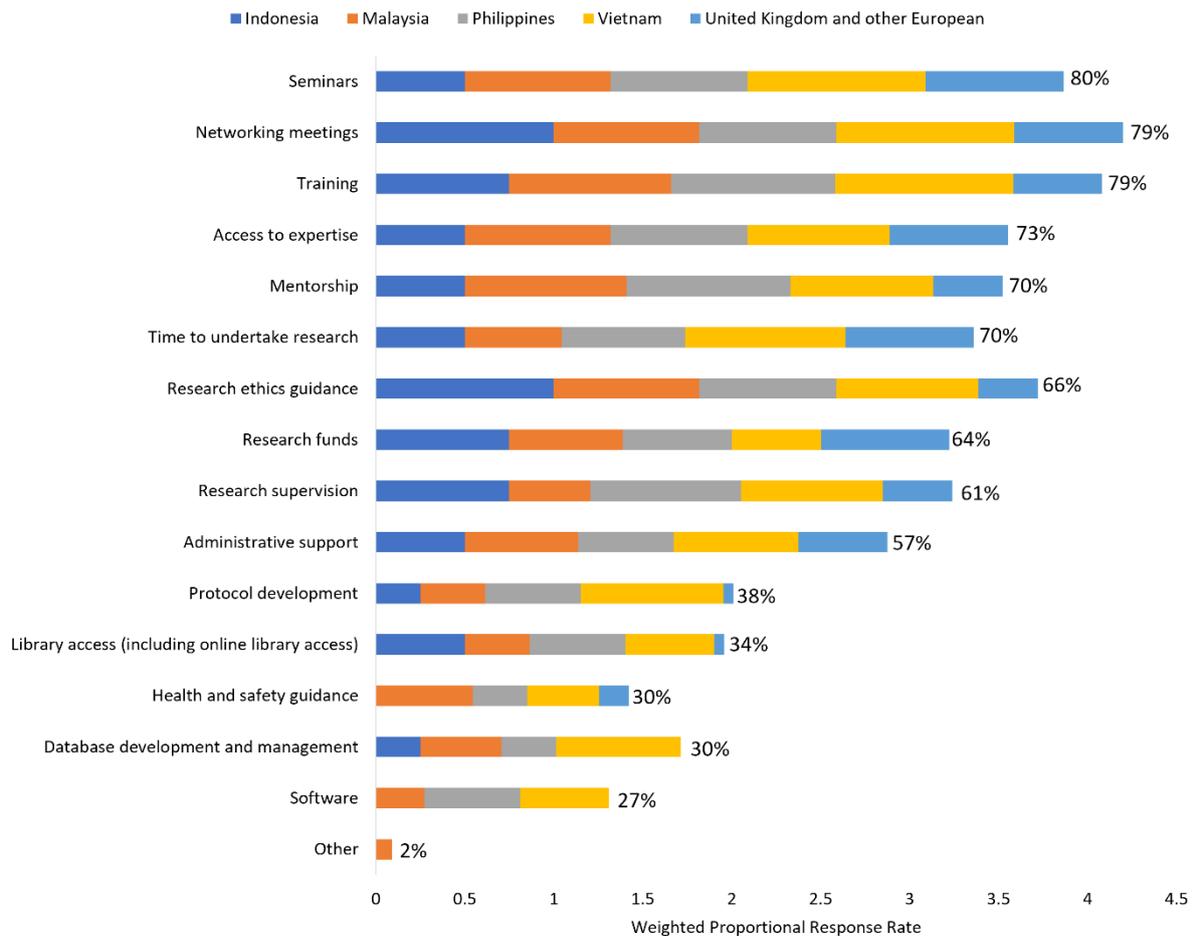
Figure 2 Resources respondents benefited from through the Blue Communities partnership. Respondents could choose as many options as were relevant. Percentage value given at the end of each bar is the total response rate (e.g. 100% would represent that all this question's respondents chose that option), while 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, all

respondents across regions and career stages valued interdisciplinary and international working, and

improving their subject understanding and knowledge (Figure 3). Early career researchers in

particular also valued publishing papers and further employment opportunities

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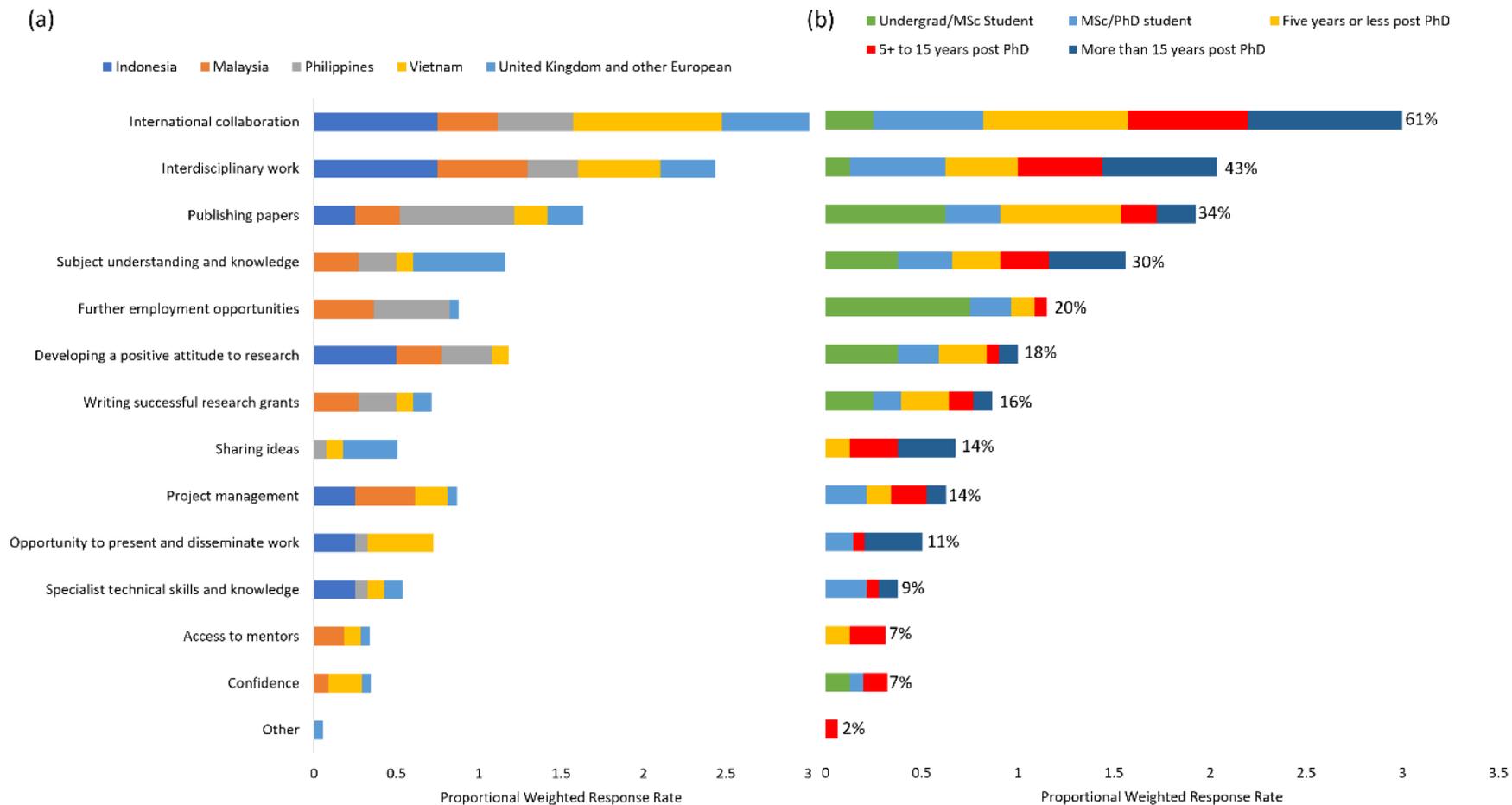
Figure 3 Research skills or opportunities respondents valued the most from their experience in Blue Communities. Respondents could choose up to three
options. Percentage value given at the end of each bar is the total response rate (e.g. 100% would represent that all this question's respondents chose that

241   option), while 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
242   respondent chose an option, each bar segment would have a value of 1).

243

244 Many of the top barriers to research that respondents identified were related to time constraints in

245 general (e.g. 'Lack of time for research', 'Desire for work/life balance', 'Other work roles take

246 priority' and 'Lack of suitable backfill') (Figure 4). These were particularly important for mid- to late-

247 career researchers. Covid pandemic restrictions was also identified as a key barrier, particularly for

248 early career researchers and SE Asian researchers. Other barriers that particularly impacted early

249 career researchers were a lack of long-term employment, personal commitments, fear of getting it

250 wrong and lack of skills. English language was identified by some respondents across career stages as

251 being a barrier. It should be noted that the survey was only available in the English language and this

252 would have excluded some potential respondents and therefore this is likely to be an underestimate.

253

(a) Indonesia | Malaysia | Philippines | Vietnam | United Kingdom and other European

(b) Undergrad/MSc Student | MSc/PhD student | Five years or less post PhD | 5+ to 15 years post PhD | More than 15 years post PhD

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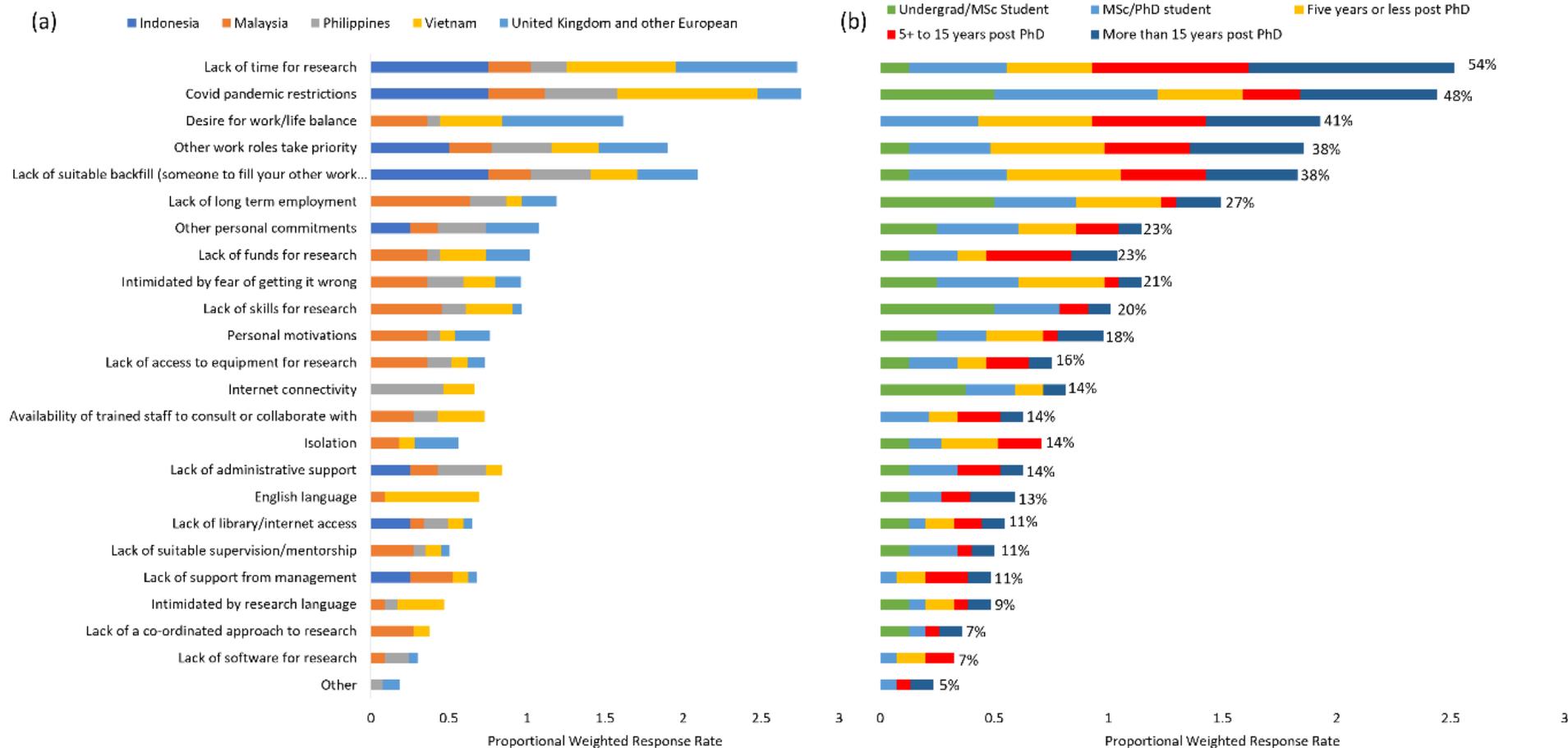
Figure 4 Barriers to research, according to participants of the Blue Communities project. Respondents could choose as many options as were relevant. Percentage value given at the end of each bar is the total response rate (e.g. 100% would represent that all this question's respondents chose that option),

15

257   while 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
258   chose an option, each bar segment would have a value of 1).

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260   When asked what personally motivates them to carry out research, respondents indicated

261   developing skills, advancing their career, making an impact (a problem that needs solving), increased

262   job satisfaction and science curiosity (Figure 5). These options were indicated across regional and

263   career stage groups, though career advancement was slightly more important for early career

264   researchers, while job satisfaction was more important for later career researchers.

265

266

(a)

Legend: Indonesia, Malaysia, Philippines, Vietnam, United Kingdom and other European

(b)

Legend: Undergrad/MSc Student, MSc/PhD student, Five years or less post PhD, 5+ to 15 years post PhD, More than 15 years post PhD

Motivator	(b) %
To develop skills	79%
Career advancement	64%
Problem identified that needs changing (e.g. improving something your local community, benefitting environment, etc.)	61%
Increased job satisfaction	54%
Desire to prove a theory/hunch, science curiosity	46%
Links to universities	46%
Increased credibility	41%
To keep the brain stimulated	41%
Opportunities to participate at own level	41%
Grant funds	32%
Dedicated time for research	32%
Research written into role description	25%
Colleagues are doing research	23%
Study or research scholarships available	23%
Research encouraged by managers	16%
Other	5%
Forms part of Post Graduate study	5%

Proportional Weighted Response Rate

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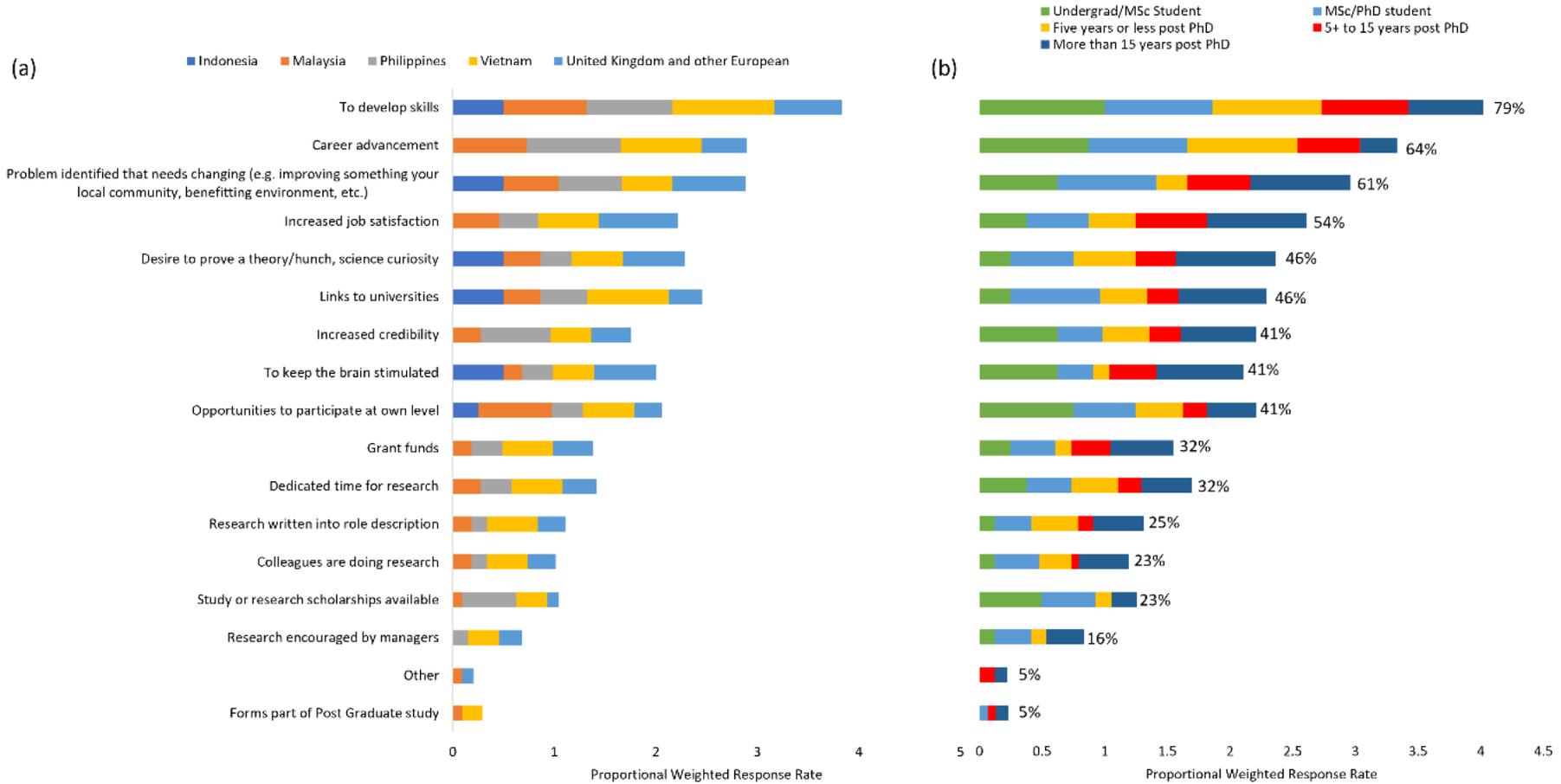**Figure 5** Personal motivators to research, according to participants of the Blue Communities project. Respondents could choose as many options as were relevant. Percentage value given at the end of each bar is the total response rate (e.g. 100% would represent that all this question's respondents chose that option), while 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).

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272

273   Across both broad regions, most respondents strongly agreed that they worked with

274   interdisciplinary teams (Figure 6 M), feel positive about working with people from different

275   disciplines in the future (Figure 6 C) and that they had the opportunity to lead research (Figure 6 E).

276   On the whole, respondents from SE Asia responded more positively across all statements.

277   Respondents from SE Asia strongly agreed that their research was relevant for making an impact in

278   their region (making a difference to society), but this was less clear for UK respondents (Figure 6 Q).

279   They also particularly agreed that they led on research questions (Figure 6 F) and publications

280   (Figure 6 G), they learnt new skills (Figure 6 H), and their career prospects improved (Figure 6 J, O).

281   They strongly agreed that they would build upon the international networks and professional

282   relationships that have been developed through the Blue Communities programme, while UK

283   respondents felt less certain about this (Figure 6 L). UK respondents felt more strongly that they

284   were limited by time (Figure 6 B) but most agreed that they learnt new skills (Figure 6 H) and project

285   managed (Figure 6 I).

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 S1, Supplementary Material.
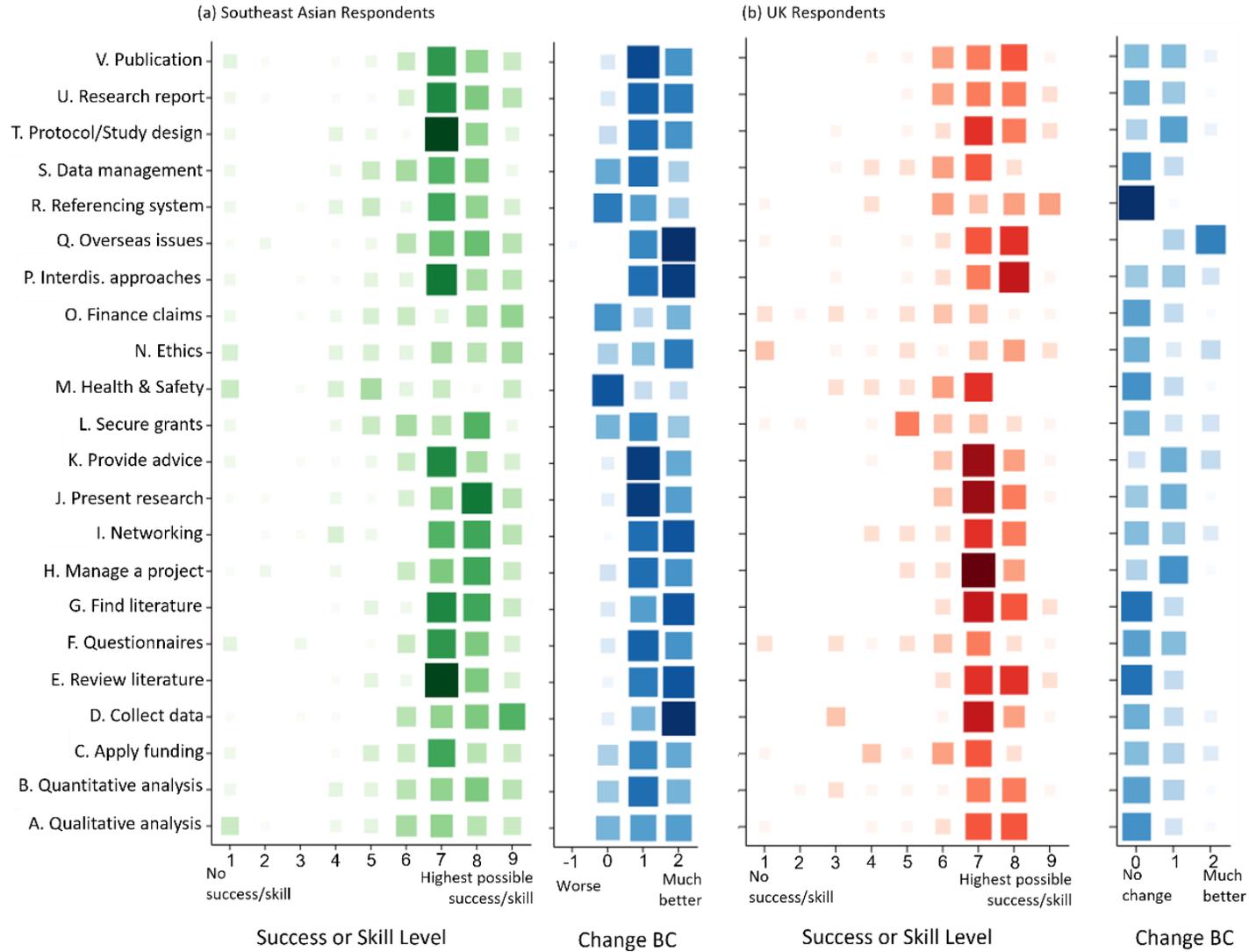
At the individual level, across both broad regions, most respondents were confident in their success and/or skill on most aspects of research capacity, rating themselves at a score of 7 or higher (Figure

295   7). Most Southeast Asian respondents were particularly confident in collecting data e.g. surveys,

296   interviews (Figure 7(a) D), and there was high confidence and low variability in finding and critically

297   reviewing literature (E, G) and in protocol/study design (T). Areas of lower confidence were in data

298   analysis (quantitative (B) and qualitative (A)), and in submitting a health and safety assessment (M) ,

299   financial claims (O) and an ethics application (N). UK (and other European) respondents felt

300   particularly confident in data analysis (Figure 7(b) A, B), finding and critically reviewing literature (E,

301   G), understanding interdisciplinary approaches and issues (P), using a computer referencing system

302   (R), and writing a peer reviewed publication (V), while they felt less confident in their success or skill

303   at securing research funding (L), and submitting ethics applications and financial claims (O).

304   In terms of change following involvement with the Blue Communities project, Southeast Asian

305   partners indicated much improvement across most markers of research capacity (Figure 7(a)), while

306   UK partners indicated no change or a smaller degree of improvement across most markers (Figure

307   7(b). However, both groups did see much improvement in the understanding of overseas issues

308   (Figure 7 Q). SE Asian respondents also saw much improvement in collecting data (D), finding and

309   critically reviewing literature (G, E), networking (I) and understanding interdisciplinary approaches

310   and issues (P). They mostly saw no change submitting health and safety applications (M), financial

311   claims (O) and in using a computer referencing system (R). Other factors were variable across

312   respondents, in particular data analysis (A,B), applying for and securing funding (C, L), submitting

313   ethics applications (N) and using computer data management systems (S). UK respondents saw some

314   improvement in managing a project (H), presenting research findings (J), providing advice to less

315   experienced researchers (K), protocol/study design (T), and writing research reports and peer

316   reviewed publications (U, V), but these were variable across respondents

(a) Southeast Asian Respondents

(b) UK Respondents

	Success or Skill Level	Change BC	Success or Skill Level	Change BC

Figure 7 (a) Southeast Asian respondent and (b) 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 (Change
BC) 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'). Larger square and darker colour indicates higher frequency of responses in the matrix plot. Research capacity aspects A-V
are abbreviated in Figure, full statements given in Table S2, Supplementary Material.
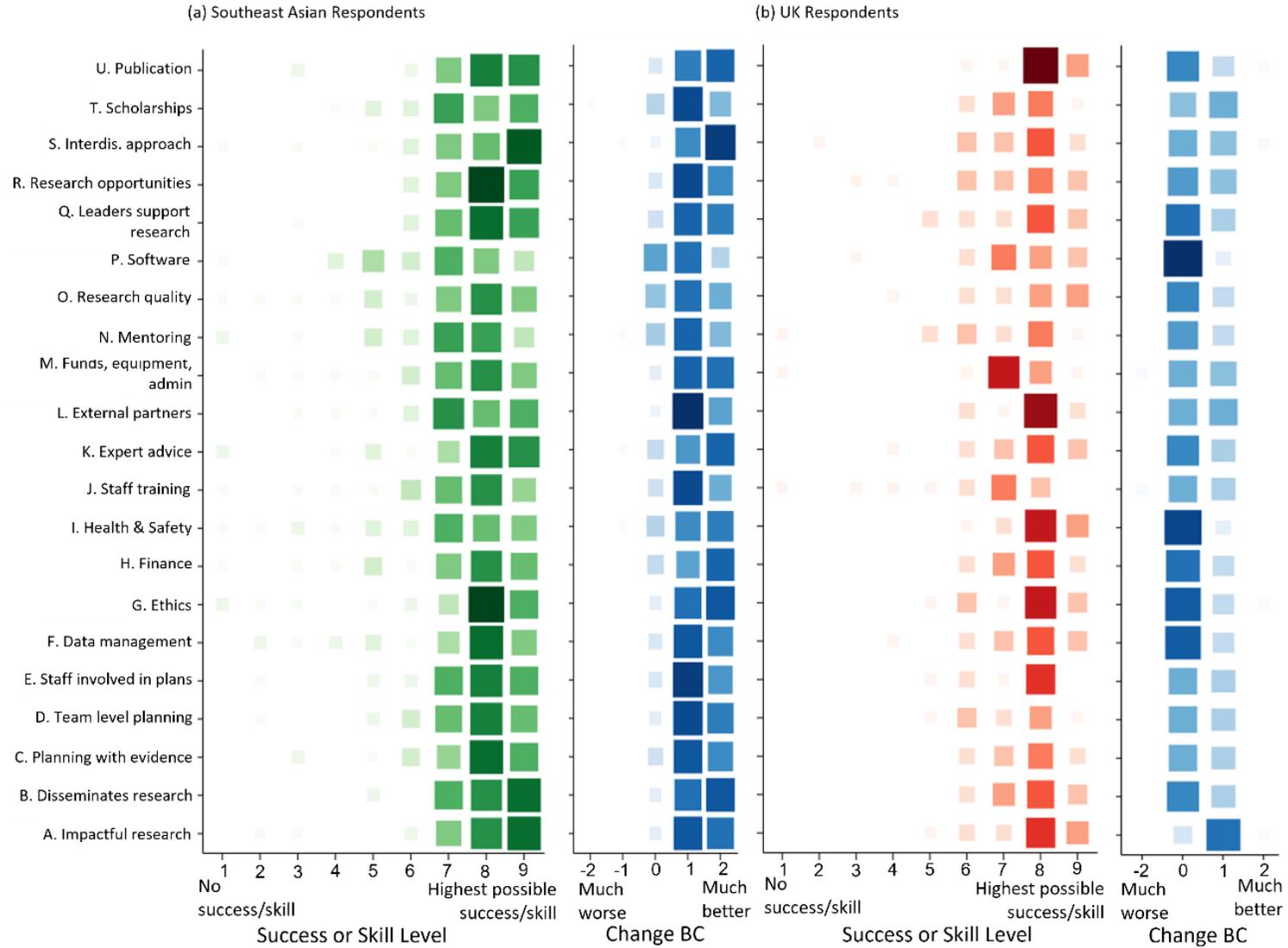
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325   *3.3 Team Level Research Capacity*

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327 At the team level (the participant's Blue Communities team at their own institution), most

328 respondents across both broad regions were confident in the success or skill of their team across

329 most research capacity markers, with SE Asian respondents being more confident and UK (and other

330 European) partners indicating more variability (Figure 8). For SE Asian respondents, particular team

331 success and skill were identified for conducting research relevant for creating impact (A),

332 disseminating research results (B) and supporting an interdisciplinary approach to research (S). Only

333 availability of software to support research activities (P) had a higher degree of variability in

334 responses. For UK respondents, teams were identified as being particularly skilled or successful at

335 supporting the publication of peer reviewed papers (U), but also in having external partners engaged

336 in research (L), having adequate health and safety and ethics support and planning (I, G) and

337 conducting research relevant for creating impact (A). UK respondents indicated higher variability in

338 several aspects, including doing team level planning for research development (D), having incentives

339 and support for mentoring activities (N), having adequate resources to support staff research

340 training (J) and having team leaders that support research (Q).

341 In terms of change following involvement with Blue Communities, there was disparity between

342 groups, with SE Asian partners finding most aspects to be better or much better (Figure 8(a)) and UK

343 respondents mostly reporting no change (Figure 8(b)). However, UK respondents did report

344 improvement conducting research relevant for creating impact (A). For SE Asian respondents, there

345 was slightly more variability for having incentives and support for mentoring activities (N), having

346 mechanisms to monitor research quality (O), and having availability of software to support research

347 activities (P).

(a) Southeast Asian Respondents

(b) UK Respondents

| | Success or Skill Level | Change BC | | Success or Skill Level | Change BC |

U. Publication
T. Scholarships
S. Interdis. approach
R. Research opportunities
Q. Leaders support research
P. Software
O. Research quality
N. Mentoring
M. Funds, equipment, admin
L. External partners
K. Expert advice
J. Staff training
I. Health & Safety
H. Finance
G. Ethics
F. Data management
E. Staff involved in plans
D. Team level planning
C. Planning with evidence
B. Disseminates research
A. Impactful research

1 No success/skill   2   3   4   5   6   7   8   9 Highest possible success/skill

-2 Much worse   -1   0   1   2 Much better
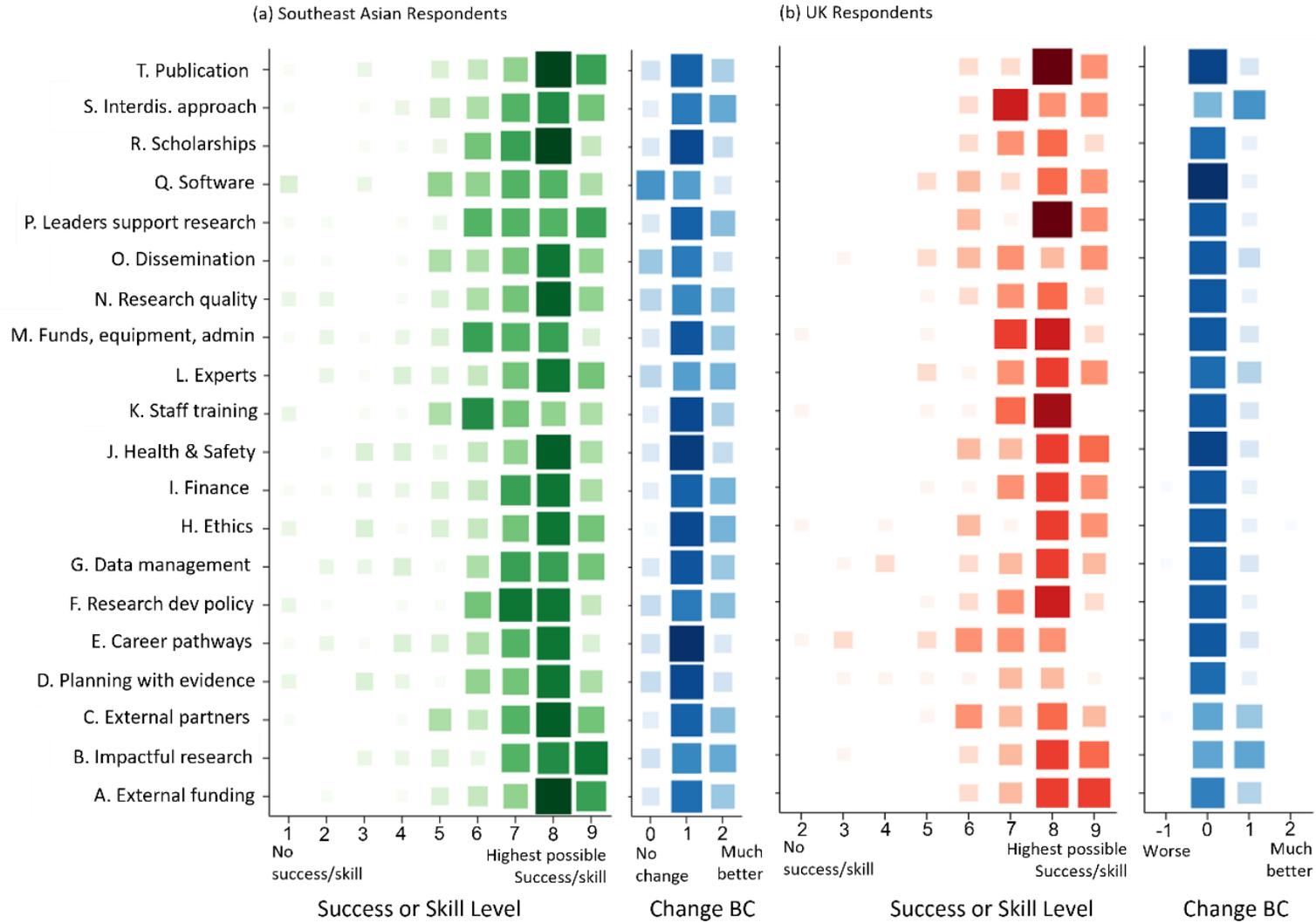
Success or Skill Level

Change BC

349   **Figure 8** (a) Southeast Asian respondent and (b) UK (and other European) respondent perceptions of their team's current success or skill level for each
350   aspect of research capacity (1=no success/skill and 9=highest possible success/skill) and change in success or skill level for each aspect (Change BC) as a
351   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
352   is 'Much better'). Larger square and darker colour indicates higher frequency of responses in the matrix plot. Research capacity aspects A-U are abbreviated
353   in Figure, full statements given in Table S3, Supplementary Material.

3.4 Organisational Level Research Capacity

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355

356 At the organisational level, again most researchers rated their organisation's success or skill highly

357 across all or most research capacity markers in both broad regions (Figure 9). For SE Asian

358 respondents, they identified particular success or skill in accessing external funding for research (A),

359 encouraging research activities relevant to creating impact (B), supporting applications for research

360 scholarship/degrees (R), and supporting the peer-reviewed publication of research (T). Greater

361 variability was found for having adequate resource to support staff research training (K) and having

362 funds, equipment or admin to support research activities (M) and having software programs for

363 analysing research data (Q). For UK respondents, particular institutional skill or success was

364 identified for supporting the peer-reviewed publication of research (T), having senior managers that

365 support research (P), accessing external funding for research (A), having a plan or policy for research

366 development (F), having adequate resource to support staff research training (K) and having funds,

367 equipment or admin to support research activities (M). Greater variability in responses was

368 indicated for having software programs for analysing research data (Q), having regular

369 forums/bulletins to present research findings (O), ensuring staff career pathways are available in

370 research (E), and ensuring organisational planning is guided by evidence (D).

371 In terms of improvement following involvement with Blue Communities, SE Asian respondents

372 reported some improvement ('Better') across all markers with little differentiation between

373 different aspects (Figure 9(a)). UK respondents on the other hand reported mostly no change, except

374 for some improvement in supporting interdisciplinary approaches to research (S), and encouraging

375 research activities relevant to creating impact (B), and to a lesser extent, accessing external funding

376 for research (A) and engaging external partners in research activities/planning (C)

(a) Southeast Asian Respondents | (b) UK Respondents

Success or Skill Level — Change BC — Success or Skill Level — Change BC

1 No success/skill ... 8 Highest possible Success/skill 9 | 0 No change 1 2 Much better | 2 No success/skill ... 8 Highest possible Success/skill 9 | -1 Worse 0 1 2 Much better

T. Publication
S. Interdis. approach
R. Scholarships
Q. Software
P. Leaders support research
O. Dissemination
N. Research quality
M. Funds, equipment, admin
L. Experts
K. Staff training
J. Health & Safety
I. Finance
H. Ethics
G. Data management
F. Research dev policy
E. Career pathways
D. Planning with evidence
C. External partners
B. Impactful research
A. External funding

379   **Figure 9** (a) Southeast Asian respondent and (b) UK (and other European) respondent perceptions of their organisation's current success or skill level for
380   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 (Change BC) as a
381   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
382   is 'Much better'). Larger square and darker colour indicates higher frequency of responses in the matrix plot. Research capacity aspects A-T are abbreviated
383   in Figure, full statements given in Table S4, 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 with respondents from SE Asia, who attributed clear improvements across multiple aspects of research capacity to their involvement in the Blue Communities project. This was particularly evident at an individual and team level but also at the organisational level. Here, evidence for the 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 respondents of this study clearly valued and felt positive about interdisciplinary and international working to make a difference to society and 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

409   transferring traditional skills but also about "*a process of strengthening relationships that enable*

410   *innovation and resilience in communities, organisations and societies*" (Woodhill, 2010), thus, the

411   process of collaborating and working together builds capacity in itself (Grieve and Mitchell, 2020).

412   The results of this survey are evidence that the researchers involved are enthusiastic, passionate and

413   engaged in working collaboratively and making a difference to society. And importantly respondents

414   expressed their hopes for continuing to work this way in the future: "*I hope to continue to cooperate*

415   *in the future, to develop the research direction of the project*" (BC project participant, Vietnam).

416   One clear example of *learning-by-doing* in action was in carrying out evidence synthesis and

417   systematic reviews. During the project a team of UK researchers who are very experienced in

418   systematic reviews ran a series of training sessions and provided ongoing guidance and support to SE

419   Asian researchers in developing their own systematic reviews with research questions relevant for

420   their region. This approach was clearly successful in that many researchers both in SE Asia and UK

421   identified finding and critically reviewing literature as being a factor they are particularly skilled or

422   successful at, and SE Asian respondents identified this as an area of much improvement because of

423   involvement with the project. Three systematic reviews were carried out for three of the SE Asian

424   partner countries, all led by SE Asian researchers (publications in progress). In addition, protocols for

425   carrying out reviews were also developed and published (Zain et al., 2022, Nguyen et al., 2020).

426   Furthermore, participants in the workshops have since gone on to teach the method to others in

427   their institution, demonstrating the sustainable nature of this capacity building.

428

429   Notably, lead authorship in this study was well distributed between participants from different

430   countries and respondents clearly appreciated this, as one respondent described their team's

431   motivation as being "*the independence granted to develop and pursue research questions*" (BC

432   project participant, Indonesia). This is in contrast to many studies that show disparity in lead

433   authorship between high- and low-income partner countries. For example, Harvey et al. (2022)

434   found only 14% of 230 publications considered were led by a researcher from an African institution.

435   Interdisciplinary research, by nature, requires input from a diversity of partners coming from

436   different knowledge backgrounds but power imbalances can mean that these different actors do not

437   always contribute sufficiently (Steelman et al., 2021). A key feature of Blue Communities was that it

438   was decided from the outset that early career researchers, in particular those from SE Asian partner

439   institutions, would be prioritised in terms of leading research and publications, and were supported

440   by more senior staff in doing this. In addition, the project established an Early Career Researcher

441   Network, that encouraged members to apply for additional funding to support their own research

442   questions, host seminars and share skills. Having this set out clearly and supported with leadership

443   meant these power imbalances were explicitly addressed.

444   The COVID pandemic restrictions presented a challenge, as reported by respondents, especially early

445   career and SE Asian participants. This was through inability or reduced time to visit field sites and

446   collect new data, inability to meet project partners in person, and potentially more difficulty with

447   internet or resource access, as well as other personal factors. This is likely to have impacted capacity

448   building through impacting development of personal relationships. Despite this, partners responded

449   positively across most research capacity markers. Teams adapted quickly to the new situation and in

450   some cases changed their focus. Indeed, partners in the project demonstrated good practice in

451   moving activities online in a sensitive and structured way (Richter et al., 2021). In some, but not all

452   cases, project participants recognised that they were fortunate to have the pandemic come later in

453   the project so that personal relationships were already well established. However, where this was

454   not the case, partners demonstrated concerted effort in building relationships online. For example,

455   Richter et al. (2021) emphasised the importance of using icebreakers in the virtual environment. This

456   made a relatively smooth transition to moving capacity building elements and research working

457   online.

458   Most respondents felt positive on a personal level about leading research questions and

459   publications, learning new skills, and improving their career prospects. One respondent reflected:

460   "*my involvement at the Blue Communities has increased my visibility in the local academia. This*

461   *program has also significantly impacted my research and project management skills. Most*

462   *importantly, my involvement with the Blue Communities has paved my career path in significant*

463   *ways*" (BC project participant, Malaysia). This shows that concrete and sustainable capacity building

464   has been achieved during the project, so that partners can carry on with this type of research

465   independently into the future.

466

467   *4.2 Challenges for sustainable current and future research capacity*

468

469   An issue identified previously in research projects that aim to create impact in solving global

470   challenges and build capacity is the conflict between research aims (e.g. advancing knowledge and

471   publishing papers), influencing policy and building capacity (Harvey et al., 2022). Harvey *et al*.

472   acknowledge that a common strategy is often used to achieve these aims, but this may not be

473   appropriate for all, and research aims can be given priority. This conflict clearly emerged during the

474   Blue Communities project. The majority of respondents to the survey were on fixed term contracts

475   and, traditionally, publishing papers is important for career advancement, while even established

476   researchers depend on their publication record in winning further research funding. Early career

477   researchers in particular valued publishing papers and further employment opportunities, but

478   publishing was important for many respondents with several mentioning publishing papers as a

479   motivator for their team, and one respondent describing the motivation to be the "*Esteem and*

480   *recognition for good research published, contributing to career development and attraction of*

481   *further research funding for self-determined research pathways*" (BC project participant, UK).

482   However, tension with these motivations and the aims of building capacity and achieving real impact

483   in communities and how this is recognised for individuals, was also felt, as one respondent

484   described: "*I'd say some team members are too obsessed with papers as a marker of success, and*

485   *universities do not sufficiently recognise the value of impact in their promotion criteria*" (BC project

486   participant, UK).

487   This tension may be driven particularly by the UK side where researchers may feel under more

488   pressure to publish for their career progression and to meet expectations of funding bodies. For

489   example, one SE Asian respondent noted that "*I'm now appointed as a Senior Lecturer at a local*

490   *university, and one thing that got me into this job is because my employer values my networking with*

491   *the international, multidisciplinary research team of BC*" (BC project participant, Malaysia) indicating

492   that the values in UK universities may differ from those in other cultures (Hoang, 2021). Overall,

493   across all markers and at all levels, SE Asian participants responded more positively than UK

494   participants. Several factors may explain this e.g. the markers given may not capture adequately

495   what UK participants may have benefited from nor what adequately evaluates interdisciplinary

496   aspects of research capacity (Steelman et al., 2021). However, it could also be that in some cases

497   participants felt capacity building was acting mainly in one direction. For example, one respondent

498   said "*Compared to traditional research projects, the career progression opportunities for UK teams*

499   *may have [conversely] advanced less. The focus was on capacity development, rightly, but this may*

500   *have inadvertently reduced the scientific innovation and output from UK teams because of the*

501   *amount of time needed to support the partner teams*" (BC project participant, UK). Indeed, UK

502   respondents felt more strongly that they were limited by time to achieve the outputs they wanted.

503   While most agreed that they learnt new skills and project managed, if these attributes are not

504   obviously valued in their career pathways, individuals may also not value these highly. UK

505   respondents identified a weakness in their institutions in ensuring career pathways were available

506   for their research staff. Considering that interdisciplinary researchers tend to publish less at first and

507   have greater difficultly in demonstrating research productivity than more traditional researchers

508   (Steelman et al., 2021), the lack of career pathways will only exacerbate the conflict between

509   research aims, building capacity and making impact.

510   In some cases, within the project, researchers did prioritise research aims. Other studies of

511   international consortia have reported that researchers in the Global South can feel like 'data

512   sources' in that they are not heavily involved in planning or analysing data, but only in commenting

513   on it; that responsibility stays in the North (Harvey et al., 2022). In the Blue Communities project,

514   while the UK researchers were less involved in the collection of data, it was clear that SE Asian

515   respondents were involved in all aspects of research, from planning, to collecting data, to analysing

516   and interpreting. However, data analysis was identified by SE Asian respondents as an area of

517   potential weakness, while UK respondents identified it as a strength, and therefore there may still be

518   some reliance on UK researchers in this area. There were instances throughout the project where SE

519   Asian partners sometimes deferred to UK partners to carry out complex analyses. For example, one

520   respondent observed: "*Some* [sub-]*projects, while providing training at annual meetings, ended up*

521   *doing the analysis for the partners rather than training and then letting partners take ownership of*

522   *the research. This is reflected in some* [sub-]*projects not having many papers lead authored by* [SE

523   Asian] *partners*" (BC project participant, UK). Harvey et al. (2022) emphasised the importance of

524   being willing to fail as part of a learn-by-doing process, thus sometimes sacrificing high-impact

525   research outputs to focus on capacity development. Although this was not ubiquitous in this project,

526   it has left gaps in research capacity of participants in some areas, potentially impacting their future

527   autonomy.

528   It was unexpected that UK respondents did not feel more strongly that their research capacity

529   improved, in particular in relation to applying and understanding interdisciplinary approaches. UK

530   respondents only strongly identified improvement in a greater understanding of overseas issues.

531   This particular marker may encompass a multitude of factors, and it may be that the parameters

532   provided in the survey do not adequately articulate what UK researchers did learn from involvement

533   with the project. It is important to identify these parameters and ensure more active two-way

534   dialogue in future collaborations, so that UK or other participants from HIC are mutually learning

535   from their project partners. Although UK researchers may have seen themselves more in the role of

536   delivering research capacity than receiving it, there are important reasons for mutual learning and

537   capacity strengthening. UK researchers did not identify the project as having an impact in their

538   region. This is not totally unexpected since UK partners were not working directly with local

539   communities as SE Asian partners were. However, there are areas that could have potential impact

540   in the UK. For example, the current discourse in the UK on the need to decolonise the curriculum

541   (Schucan Bird and Pitman, 2020) would clearly benefit from researchers who have experience

542   working with other cultures and introducing this diversity through their teaching and research

543   citations. In addition, researchers working directly with communities in LIC on sustainability issues

544   try to highlight the knowledge that is held in the Global South as "*the limited Western view of*

545   *sustainability is stifling progress*" (Nagendra, 2018). SE Asian partners instigated a wealth of

546   approaches throughout the project, working creatively with local communities and practitioners. For

547   example, researchers in Indonesia carried out participatory film making with local communities

548   addressing sustainability issues, which resulted in changes in environmental behaviours and the

549   formation of a film making community group dedicated to making audio visual work on behavioural

550   change related to plastic pollution and climate change. Another example from Malaysia saw

551   engagement with local communities resulting in greater attendance to health centres and vaccine

552   uptake. More work is needed to reflect on and recognise the learning of UK partners in this

553   collaboration. However, this may become more apparent over the longer term than at the point this

554   survey was carried out.

555   There was clear disparity in resources at organisational level between UK and SE Asia, with SE Asian

556   respondents identifying funds, equipment or admin to support research activities and having

557   inadequate resources to support staff research training, while UK respondents reported their

558   organisations were good in both of these. In other studies, participants have felt that it is important

559   to recognise this organisational inequality to manage expectations and ensure a meaningful

560   partnership (Grieve and Mitchell, 2020). Development is still needed at an institutional or

561   organisational level to reduce inequality in these factors, as there can be a lack of investment at

562   higher levels, beyond the individual (Harvey et al., 2022). Despite this, SE Asian respondents felt

563   strongly that they would build upon the international networks and relationships developed through

564   the project, while UK respondents felt less certain. During the life of this project, the UK Government

565   reduced Overseas Development Aid funding resulting in cuts to funding in this and similar projects.

566   Several respondents mentioned funding cuts as a barrier to their teams, and this may further explain

567   the more pessimistic outlook of UK respondents in being able to continue these research

568   collaborations into the future, as the opportunities for doing so have been drastically reduced.

569   Many respondents felt lower confidence in submitting health and safety assessments, financial

570   claims, and ethics applications, particularly at an individual level. While not all respondents would

571   have needed to participate in these aspects, and that may explain some of the variability, these

572   aspects may reflect a lack of facilities or support for these within organisations but also that they can

573   be complex administrative processes where rules can be unclear even where facilities are well

574   developed. For example, one respondent mentioned the "*bureaucracy of financial process*" (BC

575   project participant, Philippines) as a barrier to their team. Additionally, ethics applications are often

576   reviewed by individuals on an ethics committee and responses to applications can depend strongly

577   on the individual reviewers which can vary from organisation to organisation. Similar studies have

578   also found efficiency of researchers to be inhibited by bureaucracy or technical and administrative

579   support in time-limited research projects (Grieve and Mitchell, 2020, Harvey et al., 2022). This

580   project worked with organisations to develop their ethical approval processes, financial

581   management and risk assessment, and there is variability in these depending on the specific

582   location. One respondent mentioned a team barrier as being "*lack of administrative support in the*

583   *initial stage of project*" (BC project participant, Malaysia), indicating that things did improve, and the

584   survey results support this as people felt more confidence at the team level on these. Despite lower

585   confidence indicated by respondents on these aspects, from the personal observations of the

586   principal investigator and project manager (authors MA and VC on this paper), there was substantial

587   improvement of SE Asian individual, team and to some extent organisational capacity in financial

588   claims and ethics processes. This project, through learning-by-doing, adapted a flexible approach, to

589   meet the needs of researchers in different countries and organisations and adapt to their specific

590   circumstances. This included, for example, providing advances on funding to allow participants to

591   travel or take part in research activities and circumvent inhibitive administrative processes.

592

593   *4.3 Conclusions*

594

595   There are limitations to this study, specifically that most respondents came from academia, and to

596   fully evaluate a transdisciplinary project, the perspectives of other actors, such as community

597   partners, are also needed (Steelman et al., 2021). Furthermore, a longer-term assessment of

598   research capacity will be required to evaluate if it has sustained into the future beyond the life of the

599   project (Vallejo and Wehn, 2016, Hewitson, 2015). However, this study provides a broader

600   perspective on the success of a learning-by-doing approach to building research capacity than

601   focussing on research outputs such as publications and funding alone. There are key lessons

602   emerging from the outputs of this study that can be used to enhance or modify approaches used for

603   capacity building in future collaborations.

604   There is currently a difficult balance between undertaking innovative interdisciplinary research that

605   has societal impact and building sustainable research capacity. In this case, the Blue Communities

606   project would appear to have achieved advances in all of these areas, and this may have been

607   particularly aided by the relationships that were built during the project, through a collaborative

608   learn-by-doing process, that kept people enthusiastic and engaged to the end. However, gaps were

609   identified by respondents in scientific innovation and in particular aspects of research capacity, and

610 much of this may have arisen from trying to achieve these conflicting aims. Despite the project

611 recognising the importance of interactive dialogue and not just one-way training, for mutual capacity

612 building (Richter et al., 2021), UK respondents reported less capacity built across most parameters.

613 While this needs further investigation and other factors may come into play, this may in part be

614 driven by the values of UK organisations. Institutions are responsible for incentivising individual's

615 actions (Woodhill, 2010). Currently, the incentives around research and career progression within

616 research, particularly amongst HIC are focused on publishing papers, and interdisciplinary

617 researchers face challenges in having their achievements and skills recognised in traditional

618 academic career paths (Radinger-Peer et al., 2022, Fam et al., 2020, Guimarães et al., 2019).

619 Institutions and employers need to place greater value on the contributions people make in the

620 areas of strengthening capacity and making societal impact giving it equal, or higher value to

621 research publications. This is essential to mobilising interdisciplinary and transdisciplinary research

622 to solve global challenges and achieve long term sustainability. The current academic system is a

623 major barrier to achieving this long-term sustainability where people undertaking research will

624 ultimately need to think about their own career progression, and their own financial stability and

625 security.

626

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Authorship Contribution

All authors conceived the study. FC carried out the survey design 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

656

Survey Questions

658

Filter Questions:

660

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

Yes/No

664

Section 1: Demographic Questions

666

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

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

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

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

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

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

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

686

Section 2: Individual Level

688

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

691

692	•	Writing a research report, presentation or paper for publication
693	•	Writing a research protocol or designing a study
694	•	Submitting an ethics application
695	•	Submitting a health and safety assessment
696	•	Collecting data e.g. surveys, interviews
697	•	Data management
698	•	Analysing qualitative research data
699	•	Analysing quantitative research data
700	•	Writing a literature review
701	•	Applying for research funding
702	•	Networking
703	•	Project management
704	•	Interdisciplinary research approaches and issues
705	•	Secured research funding
706	•	Co-authored a paper for publications
707	•	Presented research findings at a conference
708	•	Submitted financial claims from a research grant
709	•	Other

710

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

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

716	i)	Finding relevant literature
717	ii)	Critically reviewing the literature
718	iii)	Using a computer referencing system (e.g. Endnote)
719	iv)	Writing a research protocol or designing a study
720	v)	Securing research funding
721	vi)	Submitting an ethics application
722	vii)	Submitting a health and safety assessment
723	viii)	Submitting financial claims from a research grant
724	ix)	Designing questionnaires
725	x)	Collecting data e.g. surveys, interviews
726	xi)	Using computer data management systems
727	xii)	Analysing qualitative research data
728	xiii)	Analysing quantitative research data
729	xiv)	Writing a research report
730	xv)	Writing for publication in peer-reviewed journals
731	xvi)	Providing advice to less experienced researchers
732	xvii)	Understanding interdisciplinary approaches and issues
733	xviii)	Understanding overseas issues and challenges
734	xix)	Applying for research funding/writing research grants
735	xx)	Networking
736	xxi)	Managing a project

737   xxii)   Presenting research findings

738

739

740 **Which of the following resources have you benefited from through the Blue Communities**
741 **partnership**? Tick all that apply

742 • Software
743 • Research supervision
744 • Time to undertake research
745 • Research funds
746 • Administrative support
747 • Training
748 • Library access (including online library access)
749 • Protocol development
750 • Access to expertise
751 • Database development and management
752 • Health and safety guidance
753 • Research ethics guidance
754 • Seminars
755 • Networking meetings
756 • Mentorship
757 • Other (please state)

758

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

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

765

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

767 • Lack of time for research
768 • Lack of suitable backfill (someone to fill your other work commitments)
769 • Other work roles take priority
770 • Lack of funds for research
771 • Lack of support from management
772 • Lack of suitable supervision/mentorship
773 • Lack of access to equipment for research
774 • Lack of administrative support
775 • Lack of software for research
776 • Isolation
777 • Lack of library/internet access

778   •   Personal motivations

779   •   Other personal commitments

780   •   Desire for work/life balance

781   •   Lack of a co-ordinated approach to research

782   •   Lack of skills for research

783   •   Intimidated by research language

784   •   Intimidated by fear of getting it wrong

785   •   English language

786   •   Covid pandemic restrictions

787   •   Availability of trained staff to consult or collaborate with

788   •   Internet connectivity

789   •   Lack of long term employment

790   •   Other (please state)

791

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

793   •   To develop skills

794   •   Career advancement

795   •   Increased job satisfaction

796   •   Study or research scholarships available

797   •   Dedicated time for research

798   •   Research written into role description

799   •   Colleagues are doing research

800   •   Research encouraged by managers

801   •   Grant funds

802   •   Links to universities

803   •   Forms part of Post Graduate study

804   •   Opportunities to participate at own level

805   •   Problem identified that needs changing (e.g. improving something your local community,
806   benefitting environment, etc.)

807   •   Desire to prove a theory/hunch, science curiosity

808   •   To keep the brain stimulated

809   •   Increased credibility

810   •   Other

811

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

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

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

817 I learned new technical specialist skills

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

819 I project-managed

820 I did not have time to learn all that I might have during Blue Communities

821 I wrote new research grants during my time on Blue Communities

822 I worked with interdisciplinary teams

823 I felt some types of training were missing from the Blue Communities project

824 I feel positive about working with people from different disciplines in the future

825 I have been able to answer some of my own research questions

826 I will build upon the international networks and professional relationships that have been developed
827 through the Blue Communities programme

828 I could have led more work than I did during the Blue Communities project

829 I think I will have more opportunities available to enhance my future career as a result of the work I
830 have conducted for the Blue Communities programme

831 My career level has progressed as a result of my involvement in Blue Communities

832 I thought the Blue Communities research could have been more interdisciplinary

833 My institution rewards or recognises my achievements linked to Blue Communities

834

835 Section 3 Team Level
836

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

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

843

844 i)   Has adequate resources to support staff research training
845 ii) Has funds, equipment or admin to support research activities
846 iii) Does team level planning for research development
847 iv) Ensures staff involvement in developing that plan
848 v)   Has team leaders that support research
849 vi) Provides opportunities to get involved in research
850 vii) Does planning that is guided by evidence
851 viii) Conducts research activities relevant to creating impact (e.g. making a difference to society,
852   SDGs, local communities, policies, management, etc.)
853 ix) Supports applications for research scholarships/degrees
854 x)   Has mechanisms to monitor research quality
855 xi) Has experts accessible for research advice
856 xii) Disseminates research results at research forums/seminars

857	xiii)	Supports an interdisciplinary approach to research
858	xiv)	Has incentives and support for mentoring activities
859	xv)	Has external partners (e.g. government agencies, communities, public) engaged in research
860		activities/planning
861	xvi)	Supports the peer-reviewed publication of research
862	xvii)	Has software available to support research activities
863	xviii)	Has adequate ethics support and planning
864	xix)	Has adequate health and safety support and planning
865	xx)	Has adequate data management support and planning
866	xxi)	Has adequate finance management support and planning

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

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

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Section 4 Organisation Level

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873   For each aspect, firstly rate *your perception* of your organisation's (e.g. your University, Research
874   Centre, NGO, etc.) success or skill level (1=no success/skill and 9=highest possible success/skill): 1-
875   9/unsure,

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

879	i)	Has adequate resource to support staff research training
880	ii)	Has funds, equipment or admin to support research activities
881	iii)	Has a plan or policy for research development
882	iv)	Has senior managers that support research
883	v)	Ensures staff career pathways are available in research
884	vi)	Ensures organisational planning is guided by evidence
885	vii)	Access external funding for research
886	viii)	Encourages research activities relevant to creating impact (e.g. making a difference to
887		society, SDGs, local communities, policies, management, etc.)
888	ix)	Has software programs for analysing research data
889	x)	Has mechanisms to monitor research quality
890	xi)	Has experts accessible for research advice
891	xii)	Supports interdisciplinary approaches to research
892	xiii)	Has regular forums/bulletins to present research findings
893	xiv)	Engages external partners (e.g. government agencies, communities, public) in research
894		activities/planning
895	xv)	Supports applications for research scholarship/degrees
896	xvi)	Supports the peer-reviewed publication of research
897	xvii)	Has adequate ethics support and planning
898	xviii)	Has adequate health and safety support and planning
899	xix)	Has adequate data management support and planning
900	xx)	Has adequate finance management support and planning

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903   Any other comments: Free text

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907   **Table S1** Codes and full statement associated with Figure 6 in the main text

Letter code given in Figure	Full statement associated with code
A	I could have led more work than I did during the Blue Communities project
B	I did not have time to learn all that I might have during Blue Communities
C	I feel positive about working with people from different disciplines in the future
D	I felt some types of training were missing from the Blue Communities project
E	I had the opportunity to lead research work and/or contribute ideas that directed the research
F	I have been able to answer some of my own research questions
G	I have had the opportunity to be the lead author on one/more than one publication
H	I learned new technical specialist skills
I	I project-managed
J	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
K	I thought the Blue Communities research could have been more interdisciplinary
L	I will build upon the international networks and professional relationships that have been developed through the Blue Communities programme
M	I worked with interdisciplinary teams
N	I wrote new research grants during my time on Blue Communities
O	My career level has progressed as a result of my involvement in Blue Communities
P	My institution rewards or recognises my achievements linked to Blue Communities
Q	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

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913 **Table S2** Codes and full description of aspect of research capacity associated with Figure 7 in the
914 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

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926 **Table S3** Codes and full description of aspect of research capacity associated with Figure 8 in the
927 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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931　**Table S4** Codes and full description of aspect of research capacity associated with Figure 9 in the
932　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

938 References

939 BARRETT, A. M., CROSSLEY, M. & DACHI, H. A. 2011. International collaboration and research

940   capacity building: learning from the EdQual experience. *Comparative Education,* 47**,** 25-43.

941 BIERMANN, F., KANIE, N. & KIM, R. E. 2017. Global governance by goal-setting: the novel approach

942   of the UN Sustainable Development Goals. *Current Opinion in Environmental Sustainability,*

943   26-27**,** 26-31.

944 CHEUNG, V. V., BELL, A., CREENCIA, L. A., FLEMING, L. E., GOH, H. C., MAHARJA, C., MORRISSEY, K.,

945   RICHTER, I., THEN, A. Y. & AUSTEN, M. C. 2021. Blue Communities in Southeast Asia.

946   *Environmental Scientist,* 30**,** 96-102.

947 CHU, K. M., JAYARAMAN, S., KYAMANYWA, P. & NTAKIYIRUTA, G. 2014. Building Research Capacity

948   in Africa: Equity and Global Health Collaborations. *PLOS Medicine,* 11**,** e1001612.

949 DANGLES, O., LOIRAT, J., FREOUR, C., SERRE, S., VACHER, J. & LE ROUX, X. 2016. Research on

950   Biodiversity and Climate Change at a Distance: Collaboration Networks between Europe and

951   Latin America and the Caribbean. *PLOS ONE,* 11**,** e0157441.

952 FAM, D., CLARKE, E., FREETH, R., DERWORT, P., KLANIECKI, K., KATER-WETTSTÄDT, L., JUAREZ-

953   BOURKE, S., HILSER, S., PEUKERT, D., MEYER, E. & HORCEA-MILCU, A.-I. 2020.

954   Interdisciplinary and transdisciplinary research and practice: Balancing expectations of the

955   'old' academy with the future model of universities as 'problem solvers'. *Higher Education*

956   *Quarterly,* 74**,** 19-34.

957 FRANSMAN, J., HALL, B., HAYMAN, R., NARAYANAN, P., NEWMAN, K. & TANDON, R. 2021. Beyond

958   partnerships: embracing complexity to understand and improve research collaboration for

959   global development. *Canadian Journal of Development Studies / Revue canadienne d'études*

960   *du développement,* 42**,** 326-346.

961 GRIEVE, T. & MITCHELL, R. 2020. Promoting Meaningful and Equitable Relationships? Exploring the

962   UK's Global Challenges Research Fund (GCRF) Funding Criteria from the Perspectives of

963   African Partners. *The European Journal of Development Research,* 32**,** 514-528.

964 GUIMARÃES, M. H., POHL, C., BINA, O. & VARANDA, M. 2019. Who is doing inter- and

965 transdisciplinary research, and why? An empirical study of motivations, attitudes, skills, and

966 behaviours. *Futures,* 112**,** 102441.

967 HAMMAD, W. & AL-ANI, W. 2021. Building Educational Research Capacity: Challenges and

968 Opportunities From the Perspectives of Faculty Members at a National University in Oman.

969 *SAGE Open,* 11**,** 21582440211032668.

970 HARVEY, B., HUANG, Y.-S., ARAUJO, J., VINCENT, K. & SABIITI, G. 2022. Breaking vicious cycles? A

971 systems perspective on Southern leadership in climate and development research

972 programmes. *Climate and Development***,** 1-12.

973 HATTAM, C., BROSZEIT, S., LANGMEAD, O., PRAPTIWI, R. A., CHING LIM, V., CREENCIA, L. A., DUC

974 HAU, T., MAHARJA, C., WULANDARI, P., MITRA SETIA, T., SUGARDJITO, J., JAVIER, J., JOSE, E.,

975 JANINE GAJARDO, L., YEE-HUI THEN, A., YANG AMRI, A., JOHARI, S., VIVIAN JUSTINE, E., ALI

976 SYED HUSSEIN, M., CHING GOH, H., PHUC HUNG, N., VAN QUYEN, N., NGOC THAO, L.,

977 HOANG TRI, N., EDWARDS-JONES, A., CLEWLEY, D. & AUSTEN, M. 2021. A matrix approach to

978 tropical marine ecosystem service assessments in South east Asia. *Ecosystem Services,* 51**,**

979 101346.

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

981 HOANG, C. H. 2021. Glocal production of knowledge: exploring Vietnamese scholars' perception of

982 'good' research. *Compare: A Journal of Comparative and International Education***,** 1-19.

983 HOLDEN, L., PAGER, S., GOLENKO, X. & WARE, R. S. 2012. Validation of the research capacity and

984 culture (RCC) tool: measuring RCC at individual, team and organisation levels. *Aust J Prim*

985 *Health,* 18**,** 62-7.

986 IPCC 2018. Global warming of 1.5°C. An IPCC special report on the impacts of global warming of

987 1.5°C above pre-industrial levels and related global greenhouse Gas emission pathways, in

988 the context of strengthening the global response to the threat of climate change, sustainable

989 development, and efforts to eradicate poverty. . IPCC.

990   KARLSSON, S., SREBOTNJAK, T. & GONZALES, P. 2007. Understanding the North–South knowledge

991   divide and its implications for policy: a quantitative analysis of the generation of scientific

992   knowledge in the environmental sciences. *Environmental Science & Policy,* 10**,** 668-684.

993   MCCLURE, A. 2020. Inclusive, participatory and reflexive learning processes for climate resilience:

994   key lessons from FRACTAL. FRACTAL working paper #9.

995   NAGENDRA, H. 2018. The global south is rich in sustainability lessons that students deserve to hear.

996   *Nature,* 557**,** 485-488.

997   NGUYEN, P. T., DUONG, M. L. & EALES, J. 2020. What is the influence on socio-economic well-being

998   of UNESCO biosphere reserves in Southeast Asia? A systematic review protocol. . Zenodo.

999   RADINGER-PEER, V., SCHAUPPENLEHNER-KLOYBER, E., PENKER, M. & GUGERELL, K. 2022. Different

1000   perspectives on a common goal? The Q-method as a formative assessment to elucidate

1001   varying expectations towards transdisciplinary research collaborations. *Sustainability*

1002   *Science*.

1003   RICHTER, I., GABE-THOMAS, E., MAHARJA, C., NGUYEN, T. H., VAN NGUYEN, Q., PRAPTIWI, R. &

1004   PAHL, S. 2021. Virtual Capacity Building for International Research Collaborations in Times of

1005   COVID-19 and #Flygskam. *Frontiers in Communication,* 5.

1006   SCHUCAN BIRD, K. & PITMAN, L. 2020. How diverse is your reading list? Exploring issues of

1007   representation and decolonisation in the UK. *Higher Education,* 79**,** 903-920.

1008   STEELMAN, T., BOGDAN, A., MANTYKA-PRINGLE, C., BRADFORD, L., REED, M. G., BAINES, S.,

1009   FRESQUE-BAXTER, J., JARDINE, T., SHANTZ, S., ABU, R., STAPLES, K., ANDREWS, E.,

1010   BHARADWAJ, L., STRICKERT, G., JONES, P., LINDENSCHMIDT, K., POELZER, G. & THE DELTA

1011   DIALOGUE, N. 2021. Evaluating transdisciplinary research practices: insights from social

1012   network analysis. *Sustainability Science,* 16**,** 631-645.

1013   UN 2015. United Nations General Assembly: Transforming Our World: The 2030 Agenda for

1014   Sustainable Development. Draft resolution referred to the United Nations summit for the

1015   adoption of the post-2015 development agenda by the General Assembly at its sixty-ninth

1016   session. UN Doc. A/70/L.1 of 18 September 2015.

1017   UNEP 2002. Capacity Building for Sustainable Development: an overview of UNEP environmental

1018   capacity development initiatives. .

1019   UOL 2021. University of Liverpool (UoL) Our Strategy 2026. Liverpool, UK: University of Liverpool.

1020   VALLEJO, B. & WEHN, U. 2016. Capacity Development Evaluation: The Challenge of the Results

1021   Agenda and Measuring Return on Investment in the Global South. *World Development,* 79**,**

1022   1-13.

1023   WOODHILL, J. 2010. Capacities for Institutional Innovation: A Complexity Perspective. *IDS Bulletin,*

1024   41**,** 47-59.

1025   ZAIN, M. A., SUHAIMI, J., DAHLUI, M., GOH, H. C., THEN, A. Y.-H., YAKUB, N. A., NOOR, M. I. M.,

1026   GARSIDE, R., EALES, J., JOSE, E. & KARI, F. 2022. What are the outcomes of marine site

1027   protection on poverty of coastal communities in Southeast Asia? A systematic review

1028   protocol. *Environmental Evidence,* 11**,** 2.

1029