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Neo-colonial science by the most industrialised upon the least developed countries in peer-reviewed publishing

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We are currently experiencing an era that is facing increasing global environmental and societal problems (e.g., climate change, habitat destruction and economic recession). Scientific research projects are often required to emphasize and counter the effects of inequity and globalisation, and prioritise cooperation supported by cooperative research. This paper investigates whether publication of research that is carried out in least developed countries is done in cooperation with research institutes from these countries.

The study uses the *Current Contents* database of peer-reviewed publications from more than 7,000 journals in all sciences (Biology and environmental sciences; Physical, chemical and earth sciences; Engineering, computing and technology; Life sciences; Clinical medicine; Arts and humanities; Social and behavioral sciences) published between 1 January 1999 and 3 November 2000. From a total of 1,601,196 papers published, 2,798 articles of research activities carried out in the 48 least developed countries were selected using title information as an indicator. Collaborative relationships between research institutions involved was then analysed within and between countries and sciences. Our results show that publications of research, carried out in the least developed countries, do not have co-authorship of local research institutes in 70% of the cases, and that a majority of the papers is published by research institutes from the most industrialised countries in the world. We employed the use of questionnaires sent to authors from papers in the above-mentioned database to detect possible causes of this high percentage of lack of authorship in the essential academic currency that 'publications' are. 'Neo-colonial science' is identified as one of them. In addition, there exists a large discrepancy between what the surveyed scientists say they find important in international collaboration and joint publishing, and the way they act to it. However, the interpretation given to the fact that institutional co-authorship is underrepresented for local research institutions in the least developed countries is less important than the fact itself, and future research should concentrate on a scientific way to equilibrate this adverse trend.

Introduction

Academic research is a driving force behind the innovation in basic, applied, social, human and life sciences and therefore in society. The quality of such research is often validated under the form of scientific publications in peer-reviewed journals, that may be either oriented towards all fields of science (e.g., *Science*, *Nature*) or focused on a

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specific science field (e.g., *Biogeochemistry*, *Journal of Consumer Research* or *Cerebrovascular Diseases*). Whereas a variety of bibliometrical quality-indicators have been presented in the past such as the (Harmonic) Mean Response Time (*Schubert & Glänzel*, 1986; *Glänzel*, 1992) or the Mean Reference Age (*Glänzel & Schoepflin*, 1999), today the quality of many peer-reviewed journals is being assessed by the Impact Factor, the Immediacy Index and the Cited Half-Life. *Amin & Mabe* (2000) report that the impact factor has become the chief quantitative measure of the quality of a journal, its research papers, the authors, and even the institutions they work in. It has become widely acknowledged by scientists and institutes world-wide to do collaborative research and to publish significantly accordingly, two consecutive events according to *Melin & Persson* (1996).

Our era is facing increasing global environmental and societal problems (e.g., climate change, habitat destruction and economic recession), necessitating research cooperation between industrialised and developing countries for certain aspects, as required by funding institutions such as the European Commission, the International Foundation for Science, United Nations Development Programme, World Bank, World Health Organisation, United Nations Educational, Scientific and Cultural Organization as well as numerous national institutions. Whether or not such collaboration is a requirement of the funding agencies within the framework of international North-South cooperation, the above-mentioned global importance of scientific publishing places a publishing responsibility on all research institutes North and South. This responsibility serves not only to disseminate one's own expertise, but also to justify the research carried out and, most important, to share information. In fact, the citation attractivity of internationally co-authored publications shows that scientific collaboration is advantageous for both developing and industrialised countries (*Glänzel* et al., 1999). According to *Katz & Hicks* (1997) and *Glänzel & Schubert* (2001), the type of collaboration affects the impact of a research publication, with an increase of a factor two of the average citation for collaboration with a foreign research institute as compared to collaboration with a domestic institute.

In the light of the above, the objective of this paper is to investigate whether publication of scientific research that is carried out in the least developed countries is done in cooperation with research institutes from these countries, and to explore the possible underlying basis of authorship structure.

Material and methods

The *Current Contents* database of peer-reviewed publications from more than 7,000 journals in all sciences (Agriculture, biology and environmental sciences; Physical, chemical and earth sciences; Engineering, computing and technology; Life sciences; Clinical medicine; Arts and humanities; Social and behavioral sciences), published between 1 January 1999 (7 Editions of Week 1) and 03 November 2000 (7 Editions of Week 44), was used as primary data. The use of the *Current Contents* database of peer-reviewed publications (or other similar databases from the Institute of Science Information – ISI, Philadelphia, PA, USA) is in itself not expected to bias towards 'Western' views in the issue of science in developing countries, but it is unfortunately the only method with the only existing international database to readily examine co-authorship patterns (cf. all literature references in this paper also employed the use of the same database material from ISI, except for *Erftemeijer* et al., 2001).

In a total of 1,601,196 publications, the papers that concern research carried out in the 48 least developed countries (Appendix) were extracted based on the presence of the respective name of the developing country (hereafter referred to as 'target country') in the title. The justification for this is that scientific research specifically carried out in a certain geographic area is almost always reflected in the title. Papers where this was not the case were necessarily not retrieved, as the only way to overcome this problem is to actively read all 1.6 million papers, an unrealistic task. Nevertheless, this omission as well as the omission of papers on a variety of target countries so large that none of the country names is indicated in the title (i.e. the false negatives), is assumed to represent a negligible bias and does not seem to be skewed towards any science category. The present sample may thus constitute a slightly limited number of publications of research carried out in least developed countries compared to the true number, but it is not expected to be a biased sample : the publications that reflect their main study sites unambiguously, were selected for 100%, at least as far as they are included in the *Current Contents* database.

The sample was then screened for errors in two manual steps. First, the publications misleadingly referring to a target country (e.g., the fungus *Aspergillus niger* to Niger, or the 'guinea pig' to Guinea, Equatorial Guinea or Guinea-Bissau) were all removed. Second, within the sample of remaining articles the proportion that did not actually comprise a fieldwork component in the target country, hereafter referred to as 'false positives', was estimated by reading the abstracts of 138 randomly selected papers (maximum 3 per least developed country). Publications with more than one country in

the title were considered only once, and publications with no research institutes listed, were omitted.

In all other cases the country of origin of the research institutions authoring and co-authoring the paper (hereafter referred to as 'author countries'), the target country and the science category was entered in a spreadsheet program for further analysis. Science categories were classified as follows according to the system applied in VUB (1999):

- Basic and Applied Sciences, which include Biology and environmental sciences, Physical, chemical and earth sciences, and Engineering, computing and technology;
- Life Sciences, which include Life sciences and Clinical medicine; or
- Social and Human Sciences, which include Arts and humanities, and Social and behavioral sciences.

Institutional co-authorship relationships were then analysed between the author countries, the target countries and the three science categories. Target countries that published individually were omitted from collaboration analyses. The rationale for omitting this group from further analysis is straightforward, as otherwise it would artificially increase the number of papers with collaboration for the respective countries (which in fact is collaboration of a country with itself). Within the subsample that included target countries as (co-)author countries, a distinction was made between various author positions. The results were also analysed from the view point of the most industrialised author countries (i.e., Canada, France, Germany, Italy, Japan, United Kingdom and United States of America, also known by the term 'G7').

The χ^2-test or G-test (*Sokal & Rohlf*, 1981) were used to test significant differences ($p<0.05$) between the science categories or author countries.

In order to gain a better understanding of the assumptions used and results obtained, substantial investigation for causes underlying trends in the data was necessary. Causes for omission of the target country as an author country was investigated through literature research, group discussions with scientists and by analysing the questionnaire answers from 80 corresponding authors, who responded in a total of 447 contacted (Table 1). The proportions of the respondents' author countries and science categories were not significantly different from those obtained from the *Current Contents* database (respectively $\chi^2 = 5.511$; d.f. = 4; n.s.; and $\chi^2 = 1.429$; d.f. = 2; n.s.).

Table 1. Questions, statements or issues answered or commented upon by 80 corresponding authors. Depending on the type of question the original answer categories were open ended, binary or scaled from 1 to 5

* Importance of publishing in international peer-reviewed journals in general, and for scientists from developing countries in particular.
* Collaboration with local institutions within international research projects : (a) to work out the research proposal, (b) to collect data, (c) to analyse data and statistical work, (d) to write a paper.
* Co-authorship is an outcome of collaboration. What is required to merit co-authorship ?
* Did you go to the country named in the title of your article in order to collect data ?
* Local institutions in developing countries should not be involved in scientific research carried out by foreign research groups.
* Scientists from industrialised countries are more reliable in their scientific activities than scientists from developing countries.
* When drafting a scientific paper the involvement of all research colleagues should be carefully assessed with the aim of including them as co-authors.
* How important (in terms of self-esteem, CV, recognition etc.) is international scientific collaboration:
  (a) for scientists from industrialised countries; (b) for scientists from developing countries.
* Are the following statements or situations about cooperation, for your field of research, true or false ? Indicate whether they are an advantage, disadvantage or of little importance.
  (a) Local scientists know how to work in their country; (b) Local scientists have the experience with the research methodology needed; (c) Local scientists gain scientific expertise through international collaboration in research; (d) Visiting scientists gain scientific expertise through international collaboration in research; (e) Collaboration as such in my field of research is uncommon and no asset; (f) Collaboration in my field of research will slow down the research; (g) Local scientists can come up with efficient solutions for sampling problems in the field; (h) The cultural difference has an impact on cooperation; (i) There are no funds to financially support inclusion of local scientists; (j) Local institutions take no initiative to get involved in research carried out in their country; (k) There are no local scientific institutions to collaborate with.
* Does your research fall under 'development cooperation' *sensu lato* ?
* Specify ways (if any) in which you collaborated with local scientific institutions other than generating co-authored articles (Table 2).

Results

In the total of 1,601,196 publications published between 1 January 1999 and 3 November 2000, 2,798 publications concerned research carried out in least developed countries. The proportion of false positives of this selection was estimated at maximum 21%, but is likely to be less, as on one hand it is not clear whether or not there has been a fieldwork component (particularly in the social and human sciences), and on the other hand research is based on material present in the author country such as blood samples or rocks and minerals, that originate from the target countries. The division of the 2,798

publications over the three science categories was significantly different (χ^2 = 99.329; d.f. = 2; p < 0.001), with the Basic and Applied Sciences counting 1,158 (42%) publications, the Life Sciences 912 (31%) and the Social and Human Sciences 728 (27%). Among the 2,798 papers, 523 (18%) were published by the target country without collaboration, and therefore ommitted from further analysis. The remaining 2,275 papers were analysed for co-authorship patterns.

Figure 1 shows that 69% of the publications of research carried out in least developed countries by at least one industrialised author country, are done without including local research institutes. This percentage appears to be variable according to the science category with Life Sciences having a much better collaboration percentage (65%) than Basic and Applied Sciences (27%), and a negligible collaboration for the Social and Human Sciences (5%) (Figure 1). Within the subsample of papers where collaboration exists, for each of the science categories the target country is only occupying a first author position in a minority (on average in 30%) of the cases (Figure 2), and the majority thus falls under the so-called 'safari-research' (*Acosta-Cazares* et al., 2000), i.e., research carried out in developing countries published as co-authored papers with a "developed" country (the author probably means 'Western' country or 'industrialised' country) as the lead author.

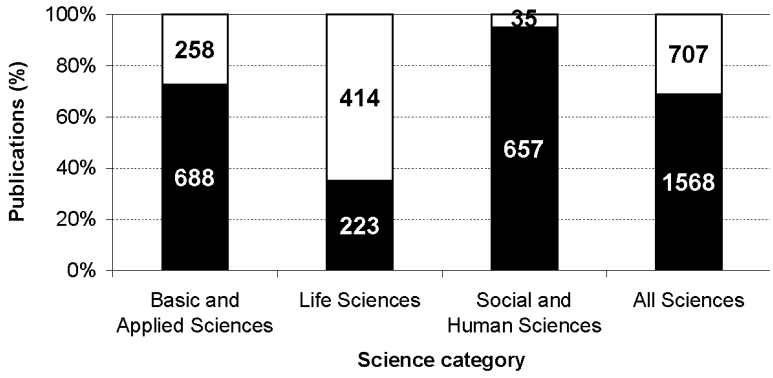

Figure 1. Numbers and percentage (histogram) of publications of research carried out in least developed countries with (white) and without (black) collaboration with local research institutes from least developed countries

When the results are sorted according to industrialised author countries (G7), the collaboration percentage with the least developed target countries is on average 29% (Figure 3), and even drops to 25% for the USA and 22% for Canada. The subdivision of these publications according to the science categories generates significantly different results from the overall results in Figure 2 ($\chi^2 = 40.885$; d.f. = 2; $p < 0.001$), with the percentages for Life Sciences and Social and Human Sciences nearly interchanged (Basic and Applied Sciences 40%; Life Sciences 26%; Social and Human Sciences 34%). The author positions of the target countries in publications co-authored by G7 author countries is not significantly different from the overall results ($0.033 < G < 2.633$; d.f. = 3; n.s.).

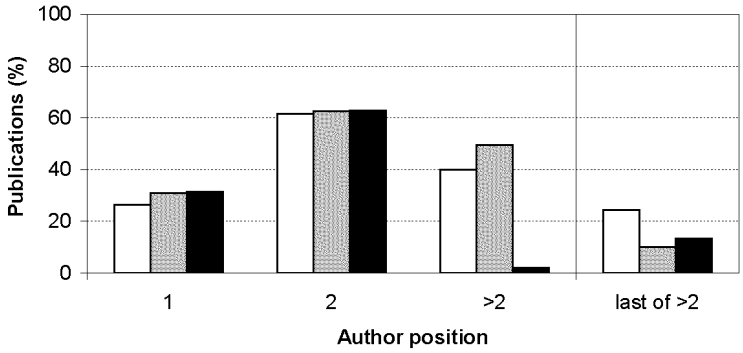

Figure 2. Author position of the 'target country' (represented by research institutes from least developed countries) as an 'author country' in joint publications (i.e. together with other author countries) on research carried out in the 'target country', for the Basic and Applied Sciences (white), the Life Sciences (grey) and the Social and Human Sciences (black). Research that does not result in a first authorship for the institute based in the target country is also referred to as 'safari research' (*Acosta-Cazares* et al., 2000). Please note that 'last' author position may overlap with 'further' (>2) author position, but it was removed from the 'second' author position category

The results are also given from the perspective of each of the target countries (Figure 4). There is no significant relation between the geographic location and the co-authorship. This can be seen from the presentation of Figure 4, but it was also tested through correlation analysis ($r^2 = 0.0246$; n = 4; n.s.). Second, Guinea-Bissau, Togo and Gambia are the only countries to display a cooperation percentage of more than 50%. Uganda reaches a percentage close to that value (48%). Third, for Guinea, Liberia,

Djibouti, Comoros and Kiribati, there is no apparent cooperation in scientific publishing (0% cooperation). For the latter three countries the International Association of Universities (2000) does not report the existence of universities or other institutions of higher education. Yet, the same is true for nine other countries, among which Guinea-Bissau, the country with the best cooperation percentage (Figure 4), which in that case have joint publications with governmental or other non-education bodies.

Questionnaire results indicate that the greater part of corresponding authors (> 70%; n = 80) believes that both international collaboration and publishing are important and that it is common in their research field, that co-authorship is an outcome of collaboration and that it must be carefully assessed when writing a manuscript (cf. Table 1). In terms of international cooperation this majority was in favour of collaboration, arguing that local scientists are scientifically as reliable as scientists from industrialised countries, and they acknowledged that local institutes in least developed countries must be involved in scientific research undertakings by foreign groups. Specifically, they stated that this actually happened in their case on the level of proposal-writing, in situ data collection, analysis and publication. In addition, they were positive in classifying their research under 'development cooperation'.

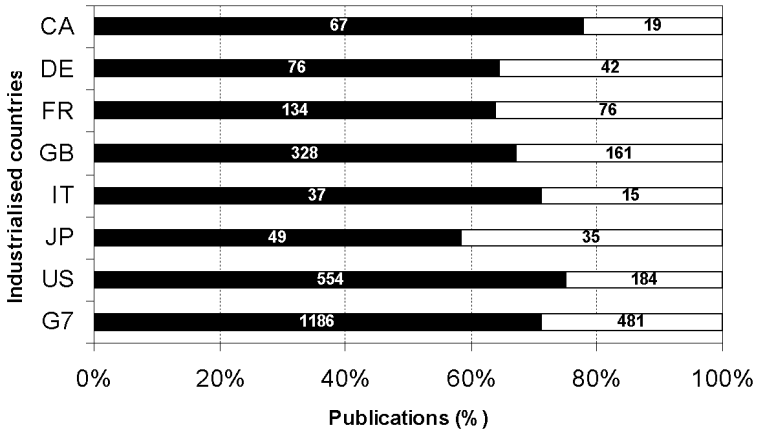

Figure 3. Number and percentage of publications of research carried out in least developed countries with (white) and without (black) collaboration with local research institutes for the G7, the most industrialised countries, and for each of its member states (CA = Canada, DE = Germany, FR = France, GB = United Kingdom, IT = Italy, JP = Japan, US = United States of America). The actual frequencies are given in the histograms

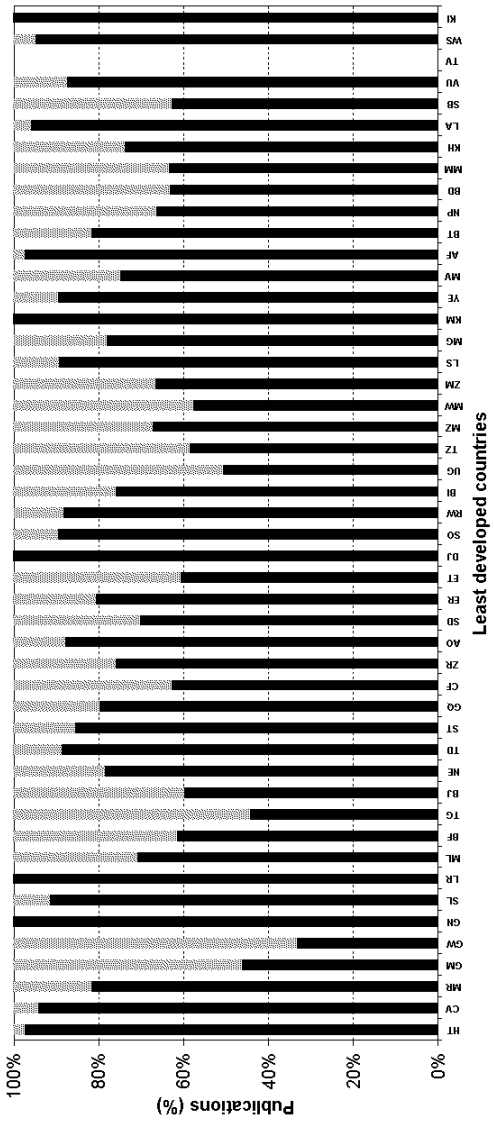

Figure 4. Percentage of publications (see the Appendix for actual numbers) of research carried out in least developed countries with (grey) and without (black) collaboration with local research institutes for each of the 48 least developed countries.
See the Appendix for full names and abbreviations

There are apparent discrepancies that exist between these views and the collaboration data extracted from the *Current Contents* database of peer-reviewed publications in general (Figures 1–4), and these discrepancies remain when each interview was checked against the individual data in the database. For instance, between 60 and 70% of the respondents state that they collaborated intensively with local research institutes, that co-authorship is an outcome of collaboration and that they evaluate this carefully when drafting a manuscript, while in fact they published the research results without involving the respective local institutes as co-authors. Within the above sample almost 40% of the research comprised more collaboration in fieldwork than actual visits to the country by the researchers personally, i.e., local research institutes carried out fieldwork for foreign research groups. The above collaboration patterns are practised by about 73% by member states from the G7, the seven most industrialised countries in the world, as compared to 27% by the rest of the world. Even if respondents (who were willing to complete the questionnaire) reflect a bias towards a socially acceptable attitude, the gap between their view and reality is striking.

Discussion

Bibliometric research results from certain science fields and geographic locations display strong co-authorship links among and between countries in North-America and Europe (incl. countries and territories in transition, particularly in Central and Eastern Europe) that reflect geopolitical, historical and linguistic relationships (*Glänzel*, 2000; *Glänzel* & *Schubert*, 2001). This study however, reveals that in research in developing countries and in collaboration with them, there is an unjustifiable underrepresentation of co-authorship with research institutes from least developed countries. The variability across science categories can be explained by Life Sciences often necessitating official collaboration with local Ministries of Public Health and hospitals, whereas Social and Human Sciences have a potentially larger proportion of ex situ research (e.g., library or museum research). In Basic and Applied Sciences, on one hand the ex situ research also applies to a certain extent (e.g. research on collection material stored, such as herbaria, entomological or geological archives). On the other hand, even in remote sensing, a Basic and Applied Science field in which data are collected from a remote location (e.g., space) without the immediate need for fieldwork, international collaboration is identified as a cornerstone for future research (*Bailey* et al., 2001).

Not only are the views obtained from the respondents in the present study in strong contrast with the results extracted for peer-reviewed literature in general (Figures 1–4), also when confronted to the data specific for each of the respondents, the same lack of

collaboration on the level of scientific publishing arises. It seems that the answers on the survey questions are strongly skewed towards the socially or politically acceptable principles, but that the actions that should accompany such principles are skewed towards the opposite. This pattern reaches the extreme of local institutes carrying out fieldwork for foreign research groups, which do not even visit the respective countries, without being included as a co-author. Whether or not the execution of such fieldwork by local research institutes happened as a task in joint research projects is irrelevant, as the results are eventually published in a majority of the cases without their co-authorship. Some respondents stated that "fieldwork alone does not qualify as authorship", whereas at the same time collaboration is claimed to be always carefully assessed with the aim of including local institutes as co-authors. It is evident that the author list is limited and cannot include all individuals that have provided the least bit of information, but it seems that at the time of publication one's participation is weighted against one's contribution in such an extreme way that the researchers from the most industrialised countries are apparently the only ones that contributed significantly to a particular paper.

In the light of the respondents' answers that publication is important for all scientists and that co-authorship is a result of collaboration, the ommission of target countries as sole authors is not assumed to miss a significant number of situations in which industrialised countries have aided the research and publication process, while refusing authorship. From a moral point of view, any country obviously has the right to perform research on its own territory and publish the results independently, implying no direct need for collaboration.

Based on our research experience, in vegetation science, biocomplexity research, ethnobiology, sociology and psychology, with scientific collaborators from various developing countries (Mexico, Mauritania, Cameroon, Uganda, Kenya, Tanzania, India, Sri Lanka, Vietnam), and based on group discussions with scientists from both industrialised and developing countries, we attributed the lack of co-authorship to four possible causes, out of which three were overruled based on the results from our survey. First, *lack of confidence*, meaning that authors from the author countries did not trust the local scientists from the target countries in their scientific rigour. However, if the questionnaire survey reflects the author population, this should be overruled, as a majority of the respondents clearly stated that scientists from developing countries are not less reliable than scientists from industrialised countries. Second, *ignorance*, meaning that authors from the author countries did not realise or estimate that publications are important for developing countries as well. This was also overruled, as a majority of respondents strongly recognised the importance of publishing, in

particular for institutes in developing countries. Third, *negligence*, a failure to include local institutes involved in the research as co-authors, which a reasonably considerate person would include. This is a mistake that cannot possibly account for the observed 70% of publications of research carried out in least developed countries without co-authorship from local research institutes, even with the maximal margin of 21% false positives within this figure. Fourth, *neo-colonial science*, a spirit in science in which authors from the author countries realise the importance of publications, recognise the contribution, but deliberately and systematically exclude co-authorship of target countries.

The results from this study take us one step further (back) than 'safari research' (*Acosta-Cazares* et al., 2000) and clearly qualify in what we term 'neo-colonial science'. In cases of mere fieldwork being carried out by local research institutes for foreign research groups, without any education or training contribution and without being valorised under the form of co-authorship, maybe in some cases it even qualifies as 'exploitation of local researchers'. However, 42.5% of the respondents believe that besides generating co-authored papers, there are multiple ways in which they collaborated with local scientific institutions (Table 2). On the other hand, this may be irrelevant in the light of more than 90% of the respondents recognising both the importance of collaboration and publishing for local research institutes.

Table 2. Ways of collaboration with local research institutes in least developed countries identified by 80 corresponding authors (84% from industrialised countries and 61% from the G7)

Ways of collaboration	%
Co-authorship	57.50
Training	18.75
Capacity building	11.25
Logistic and clinical support	11.25
Policy-making and advise	7.50
Financial aid and employment	5.00
Sharing info, data and results	3.75
Carrying out research projects	3.75
Organising workshops	3.75
Monitoring and mining	2.50
Social contact	1.25

The question remains whether scientists from local research institutes in the target countries themselves believe that scientific publishing is important. On one hand, the fixed positions that such researchers obtain may be responsible for a lack of motivation

for scientific publishing. On the other hand, papers in local journals or media (the 'grey' literature) may have a more beneficial result to them. However, in a bibliometrical study on marine botanical research in East-Africa over 5 decades, *Erftemeijer* et al. (2001) reported that 54.8% of all existing publications (incl. those in local journals and grey literature) were published in international journals, books and conference proceedings, as compared to 45.2% in local journals, as technical reports and as university theses. In addition, we experienced that the scientists recognised at an international level are those that do publish in peer-reviewed journals, bringing us back to the main result of this paper: they are insufficiently included as institutional co-authors by the more industrialised countries. Maybe this unequity in co-authorship is accepted by those not included, but this should be investigated in detail. In the present paper we investigated the contribution of local scientists to a selected number of studies by interviewing the first author, amongst other parameters. This is a first step to the identification of some criteria for including study participants as authors, which will probably perform a valuable service to the scientific community, and motivate some scientists to be more inclusive in their co-author determination as well.

Conclusion

Raina & Habib (1994) raised the question whether scientists from the advanced countries view some developing countries as a source merely of data-gathering and survey-related research and not as partners. The results of this study seem to answer affirmatively to this question, and worsen the above scenario in safari-research with a neo-colonial one in which local people from developing countries do act as partners and appear to be valued as such, but are totally neglected when it comes to peer-reviewed publishing. Rather than being viewed as a subtle political tract, these facts should be dealt with at the source and should stimulate capacity building in developing countries.

The call for more Western support to the capacity building of local scientists, rather than an exploitation of them, was also launched recently for East Africa (*Erftemeijer* et al., 2001), and for India and China (*Arunachalam & Gunasekaran*, 2002). This study makes it clear that for *all* of the 'least developed countries' it is imperative that research activities concentrating on their territories also contribute to a competitive academic development of local researchers and local research institutions. This is particularly valid in the light of the increasing amount of international research projects, and in the light of valorisation of research results as peer-reviewed publications that are assumed to be quality-controlled.

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Appendix

The 48 least developed countries (with their international two-letter code), as defined by the Development Assistance Committee (DAC) of the Organisation for Economic Cooperation and Development (OECD) , are given below in alphabetical order. The numbers indicate actual numbers of publications of research carried out in each country (cf. Figure 4).

Afghanistan (AF) :	42	Angola (AO):	26
Bangladesh (BD):	280	Benin (BJ):	47
Bhutan (BT):	11	Burkina Faso (BF):	58
Burundi (BI):	22	Cambodia (KH):	53
Cape Verde (CV):	18	Central African Republic (CF):	29
Chad (TD):	10	Comoros (KM):	3
Democratic Republic Congo (ZR):	21	Djibouti (DJ):	5
Equatorial Guinea (GQ):	10	Eritrea (ER):	30
Ethiopia (ET):	213	Gambia (GM):	36
Guinea (GN):	6	Guinea-Bissau (GW):	27
Haiti (HT):	41	Kiribati (KI):	3
Laos (LA):	28	Lesotho (LS):	8
Liberia (LR):	21	Madagascar (MG):	195
Malawi (MW):	117	Maldives (MV):	9
Mali (ML):	45	Mauritania (MR):	13
Mozambique (MZ):	54	Myanmar (MM):	27
Nepal (NP):	217	Niger (NE):	58
Rwanda (RW):	43	Samoa (WS):	22
Sao Tome & Principe (ST):	7	Sierra Leone (SL):	27
Solomon Islands (SB):	28	Somalia (SO):	29
Sudan (SD):	106	Tanzania (TZ):	306
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Uganda (UG):	235	Vanuatu (VU):	33
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