# The ultra-periphery of science: three contrasting views of the Malagasy contribution - in terms of domestic research, the diaspora and specific topics -

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**Abstract**

'Peripheral' countries contribute a very small share of world publication output. This is especially true for African countries, deprived from self-sustaining academic systems by economic and political difficulties. Madagascar is an example of an 'ultra-peripheral' country, where the higher-education and research system is largely supported by international funding or direct involvement of foreign partners. But the contribution of Madagascar to knowledge advancement is not limited to it's domestic academic production. Madagascar is also a source of human resources for foreign countries, through an active scientific diaspora, a recurrent concern in emerging countries. Lastly, Madagascar is an exceptional 'provider' of topics of research interest. In this paper we have combined these points of view, mediated by three datasets extracted from ISI's Web of Science.

In terms of volume of publication, research carried out abroad on specific Malagasy topics is two or three times the total for domestic research. The same is true for the diaspora's activity. For the bulk of expatriated scientists today, the diaspora effect seems irreversible, due to the inability of Madagascar to provide good scientific working conditions, recognition and an internationally competitive standard of living. The three sets show very different thematic focuses. Domestic research, mostly carried out with international collaboration and funding, is very much aligned with the local needs (medicine, plant science) and also long-term interests such as bio-diversity. Foreign research on Madagascar focuses mainly on bio-diversity, with apparently little attention paid to topics of short-term national interest. The diaspora's research pattern is akin to its host country's profile, mainly France and French-speaking countries, with no specific involvement in Madagascar-related specialities.

## I - Introduction - context

Inequalities of development are especially acute in science, which is, geographically speaking, highly concentrated at all scales (i.e. global, continental, national and regional) and typically much more highly concentrated than economic activity. As a consequence, 'peripheral' countries contribute a very small share of world publication output. This is especially true for African countries where a large part of the output derives from various forms of collaboration with developed countries, for example with France in French-speaking Africa. The context of North-South scientific relations has changed significantly since the 1990s with the shift of aid policies towards Africa.

Elise Bassecoulard, Suzy Ramanana-Rahary and Michel Zitt, *The ultra-periphery of science: three contrasting views of the Malagasy contribution in terms of domestic research, the diaspora and specific topics*, In: Guohua Jiang, Ronald Rousseau, Yishan Wu (Eds), Proceedings of the 9th International Conference on Scientometrics and Informetrics – ISSI 2003, Dalian University of Technology, Dalian, China, 2003, 10-21.

Madagascar is an example of an ‘ultra-peripheral’ country. Economic and political difficulties have not contributed to a self-sustaining academic system. A large part of the higher-education and research system is supported by international funding or direct involvement of foreign partners. Institutional or network linkages have helped to maintain a minimum level of internationally visible activity. This point of view of an almost completely dependent research system is both accurate and partial, the contribution of a country to knowledge advancement is not limited to the academic production of that country. We propose to add to this point of view two others: firstly Madagascar as a source of human resources for foreign countries, through an active scientific diaspora, and secondly, Madagascar as an exceptional ‘provider’ of topics of research interest. Many tropical countries offer opportunities for research in very specific areas of interest in agriculture, biology, medicine and geology. Madagascar is outstanding in terms of its bio-diversity. The proportion of endemic species of flora and fauna is exceptionally high on the island (perhaps challenged only by Australia) which makes Madagascar an highly important site for various branches of ecological research.

Studying the country's participation in world science from all three perspectives will help us to understand some of the general issues associated with ‘peripheral’ research and its contribution to knowledge advancement.

Section II is devoted to data and methodology, section III to a short reminder of the background to this research, section IV to the results of our research, and section V to the discussion and conclusions.

## II - Data and Methods

### 2.1. Data

In this study, we have concentrated on measuring the fraction of Malagasy activity visible at the international level, in various fields. For this reason we have used ISI sources (Web of Science), but certain limitations in terms of coverage should be borne in mind: the study of publications from peripheral countries using international databases has to deal with the recurrent question of the representativeness of databases, the aims of which are to cover bibliographical sources of and for mainstream science. For Moravscik (1988), a promoter in the seventies of the "Philadelphia Program" advocating a better coverage of third world science, mainstream journal collections were not appropriate for a complete coverage of world science, and dramatically underestimated the contribution of the ‘periphery’. The question is twofold:

a) the coverage of country-published journals.

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[1] the authors are indebted to MJ Razanamana, professor at the Antananarivo University, coordinator of the sub-project "Virtual Bank of Data and Information on University Competencies for Enterprises" (WB/FADES SP00v1_04), where the last author was involved, for introducing them to the issues of research in Madagascar.

For particular countries, a strong case has been put by scholars for under-representation, a typical example is India, where many national journals are not covered by the SCI [see e.g. Arunachalam, 1988 on India]. The case of China has recently been examined by Ren & Rousseau (2002) and Moed (2002). For national indicators, as shown by Zitt et al. (2000, 2003) the argument is double-edged: the inclusion of many nationally-oriented journals in a database raises very difficult problems of selection and may yield an increase in publication share with very little change in citation share, thus resulting in a collapse of their apparent relative impact. A country should consider the entire range of science indicators when complaining about ISI's journal coverage. In the ultra-peripheral countries however, there are generally no home-based scientific publishing companies or associations covered by ISI, so the problem is alleviated. This is the case for Madagascar.

b) indirect biases.

Activities important in/for peripheral countries may be underestimated because of the field or language coverage of ISI journals. ISI lacunae are more likely to occur in: applied disciplines; in territory-linked topics outside the developed countries; and in non-English literature (such as in the case of privileged links with non English-speaking former colonial rulers). An unfortunate situation is for example tropical agriculture or tropical medicine. This type of field-bias becomes a country-bias for all actors specifically involved in the fields of tropical medicine and tropical agriculture. As an example, the core journal for the essential-oil field, where Madagascar is active, is not covered by the SCI and was not included in SCISearch before 1998.

As a solution, other sources, such as Pascal (INIST), might be used (being of particular interest for the French-speaking regions - Arvanitis et al., 2000) with also some biases. Specialised databases using Medline, Inspec, CAB, Biosis, CAS, might also be useful for further analyses at the sector level, however in the present work a multidisciplinary view is necessary in order to compare activity profiles. In the present article, we do not address the human and social sciences. An in-depth study of this area requires specific analyses and databases, ISI sources being strongly biased in most of these disciplines. For information, less than 40 articles with a Malagasy address were found in Social Science Citation Index for the period under consideration.

c) file extraction.

The data files were extracted from the Web of Science over a ten years period, based on the criteria detailed below (§2.2).

d) all figures are based on integer-distinct counts (presence/absence)

2.2. The three publication sets

The three points of view under scrutiny: the direct contribution of Madagascar to world science; the expatriated human resources; and the specific research questions – correspond to three sets of scientific articles. These sets, partly overlapping, are based on retrieval formulae applied to different database fields:

1st set [in] - domestic research ("in Madagascar"). The direct contribution corresponds to the articles with one or more Malagasy occurrences in the "institutional address" field. This is the common bibliometric basis for assessing national contributions. Very little noise was found in the retrieved set.

2nd set [by] not [in] - diaspora's research ("by Malagasy authors not in Madagascar"). The purpose here was to estimate, quite roughly perhaps, the contribution of the diaspora, whatever the generation. Taking advantage of the linguistic properties of most Malagasy names, we built a list 'A' of frequent and unambiguous Malagasy names, and built up the set [by] of articles with a query on authors' names belonging to this list (list 'A', Annex 1). The set of [by]not[in] papers is a default estimation of the production of the diaspora, we used this set as a pseudo-sample to estimate field-specialisation. To try and estimate the complete diaspora production, we corrected the set [by]not[in] by applying a multiplication factor depending on the frequency of individuals whose name belongs to list A, in relation to the entire Malagasy population[2]. In the [by]not[in] set, co-publication between authors with unambiguously Malagasy names is very infrequent so the correction factor based on the sets of authors, i.e. 2.5 as a rule of thumb, can reasonably be extended to the sets of articles. At this stage what is being sought is an order of magnitude, the precision of the correction factor is limited firstly for technical reasons (the nature of available sources) and secondly for obvious bibliometric reasons (Lotka's distribution of productivity).

3rd set [on] - research "on" Madagascar-specific topics. The rationale being that the Malagasy territory offers specific targets for applied research in a number of specialities especially in life sciences. The overlap between research [in]and[on] Madagascar describes the extent to which domestic science is home-oriented. The [on] set obtained by the query 'presence of the truncated forms of Madagascar/ Malagasy in the textual fields' had to be cleaned, because of some noise due in particular to the ISI 's "keyword+" field. We wanted to restrict the set to research aimed at Madagascar specifically (and not at the whole region). The set is by default, since some relevant articles escape the query if they don't mention Madagascar in the textual fields.

[2] Set 'A' was based on a list of the most frequent names in the annex of the French-Malagasy dictionary (Rajaonarimanana & Vérin, 1997), and on the examination of the official Malagasy phone directory. The proportion of individuals with names in list A as a proportion of the population with typical Malagasy names was calculated at this stage of the study on the phone directory of the capital city, as a proxy for the country. This proportion was 35%, giving us a correction factor of 2.9. The same ratio calculated within the [in] set, i.e. scientists' names in list A/ all Malagasy names, gives a lower estimate, 1.6. In the text we adopt 2.5 as a reasonable value, this might be refined by further investigation. Another estimation, by excess, can be obtained when using the entire population (i.e. also includes non Malagasy names) the correction being too large because of numerous foreigners living in the country.

2.3. Indicators

Three forms of contribution were analysed in each case: global contribution, analysis by discipline, international collaboration. The sets have been restricted to articles, letters, notes and reviews, published between 1991 and 2001. All the figures in the text refer to this period of accumulation. Annual data are provided in Annex 2.

## III - Background

3.1. The African context

Extensive studies of African science have recently been conducted by IRD, and presented in reports for UNESCO (Gaillard et al., 2002) and the EU (Waast, Gaillard, 2001-2002; see also Rossi, 1999, Arvanitis et al., 2000, Hassan, 2001, Narvaez-Berthelemot et al., 2002). These studies depict the African science over the long term. As far as "median Africa" (i.e. excluding North and South Africa) is concerned, Waast et al. consider that the recession in the 1980s and the decrease in international assistance during the 1990s led to a rather bleak situation: the withdrawal of national governments from research programs and a research steered by international rather than national agendas; the devaluation of scientific professions, favouring the 'brain drain'; and short-term market pressure. The US and Canada shifted their aid doctrines over the decade under consideration, with an increasing emphasis on engineering and technological investment, at the expense of traditional support to scientific programs and collaboration (e.g. decreasing USAid funding). European countries have maintained the principle of supporting local academic structures by way of collaboration, but the situation, according to IRD, is unsettled, especially in relation to the orientation of the EU programs (INCO-DC). The United Nations Development Program recently called for a return to a strong collaborative policy.

3.2. Basic facts about Madagascar

The Republic of Malagasy has approximately 15 millions inhabitants, and had a GDP of 3.7 billion US dollars in 1999 (250$/ person), with a 30% contribution from agriculture, 14% from industry, and 56% from the service sector. Madagascar ranks very lowly on the GDP, somewhat better on the HDI indices. About 70% of the population lives below the poverty threshold (World Bank), the literacy ratio is about 50% and two thirds of population have no access to water facilities. Considered during the colonial era as a most promising region, the nation has suffered from policy choices, under-investment in particular in private sector, high population growth rate, intensive deforestation and soil erosion, political and social turmoil (USAID diagnosis), bad hygiene conditions allowing epidemics (cholera) and natural threats (cyclones), heavy debt-service. An ambitious Structural Adjustment Program (SAP) with the World Bank and the International Monetary Fund was launched, with a debt-reduction folder, but the aid system had to be redefined after the quasi-paralysis of the country due to political events last year. These events have

jeopardised the growth trend recorded since 1997, following decades of recession. Donors, mainly European (and especially France), American and international agencies (the World Bank) have tried to encourage new growth and democratic values. According to sources quoted by Cabanes (in Waast & Gaillard, op.cit), the standard of living of 1960 might still need two decades to be recovered.

Madagascar is thus an example of a largely assisted economy. One challenge for donors is the avoidance of the self-destruction of the unique bio-diversity of Madagascar, a long-term resource, under pressure from the population's shorter term needs. International aid is targeting a variety of areas, ranging from bio-diversity and health to humanitarian assistance and governance issues.

3.3. Academic system and research

Reflecting the size of the economy, scientific production in Madagascar places it squarely within the group of 'ultra-peripheral' countries, even when compared with African or Indian Ocean regions. The IRD-UNESCO study of African science classifies Madagascar within the fourth of five groups, being the last group with a significant degree of academic production. A detailed account of Malagasy situation is found in Cabanes, op.cit.[3] Madagascar shares with many African countries a number of recurrent problems such as budget cuts, lack of recruitment, and increased brain-drain. Formerly recognised as having a good intellectual infrastructure, the Malagasy academic system has suffered from the country's decline and questionable policies such as the rejection of international collaboration in the early 1970s[4]. Since that time, research in Madagascar has undergone a persistent crisis, with recurrent problems related to all aspects of the university and research system: funding issues; status, salaries and the attractiveness of higher education professions; lack of infrastructure; and the political climate. International collaboration has slowly been re-developed over the 1980s.

Given the earlier point about realignment of North-American aid in the 1990s, research is largely supported by international programs and international collaboration in several forms: targeted program funding, in a variety of research areas, for example agriculture and biodiversity studies; assistance to the higher education system[5] and research networking between universities, institutes, NGOs, and the private sector; and scientific collaboration with international partners including their local facilities (IRD, CIRAD).

Major institutions, most of them under the Ministry of Research and the Ministry of Environment, include: FOFIFA especially in Applied Biology and Agriculture; CNARP-/CNRP in Pharmaceutical Research; CNRO in Oceanographic Research; hospitals; CNRP in Chemistry; CIDST in scientific information ; CNRIT in technology ; CNRE in environmental sciences ; and the IHSM in marine science. Two institutions are

[3] We are much indebted for these paragraphs to this author who carried out an in-depth analysis of local and international sources.
[4] except with Institut Pasteur. Formerly-French institutions were grouped within the FOFIFA.
[5] for example the French MADSUP programme.

particularly well known for their founders' dynamism: IMRA (a private institute involved in Pharmacy, Nutrition and Medicine) and INSTN (in the area of physics). Malagasy Universities have also had a difficult history, with an uncontrolled expansion in the 1970s and 1980s, followed by a brutal down-sizing in the 1990s (21,000 students in 1999). The largest university (Antananarivo) has a multidisciplinary activity and has a significant publication output, whereas regional universities (among them Mahajanga and Toliara) are more specialised. The small size of most institutions make them highly dependent on a few leading scientists' activity.

The number of teaching staff in higher education is estimated by IRD (Waast, Gaillard, op.cit.) to be 900 people, and the number of researchers in the public sector to be 260. A very small percentage of time is devoted to research. The probable full time equivalent for the number of researchers might be about 300. The total and per capita publication output are both low even by African standards. Research expenses in the 1980s were estimated at about 0.25% of GDP. The intricacy of national and international funding and projects today makes such an analysis difficult.

R. Cabanes (op.cit.) was moderately optimistic about the prospects for the country's research, which has suffered but not collapsed during the terrible difficulties of the last few decades, thanks to domestic structures (universities, IMRA, hospitals) and substantial international help. His report however came before the political turmoil of the last two years, another obstacle to the full recovery of the country's research system.

## IV - Results

### 4.1 Production and discipline specialisation

For the sake of comparison, the tables combine the three set of data.
Table 1 shows the balance of the global volumes for the three sets, using cumulative figures. Temporal series for the table in the Annex 2 shows a growth trend (also true in world shares) for the domestic production ([in] set) and foreign research on Madagascar topics. The diaspora's contribution ([by]* not [in]) has remained relatively stable.

Table 1: Global volume of publication and disciplinary scope (integer-distinct count)

| DISCIPLINE Sets | FUND BIO | MED RES | APPL BIO | CHEM | PHYS | EART H&SP | ENGIN | MATH | MULT &MIS C | ALL (%) | ALL (vol) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| [in] | 10,3 | 33,5 | 31,5 | 4,2 | 2,3 | 11,9 | 1,6 | 1,7 | 3,0 | 100 | 596 |
| [by]* not[in] | 14,9 | 24,5 | 5,3 | 17,1 | 10,7 | 4,9 | 9,8 | 12,0 | 0,8 | 100 | 609* |
| [on]not[in] | 9,3 | 4,7 | 57,6 | 1,7 | 0,2 | 21,3 | 0,9 | 0,2 | 4,1 | 100 | 1449 |
| [on]and [in] | 8,2 | 33,5 | 35,5 | 2,9 | 0,6 | 15,9 | 1,0 | - | 2,4 | 100 | 409 |

* on list A (before application of the correction factor)

The first row [in] depicts the publications with a Malagasy address, in terms of a traditional bibliometric approach. The total number of publications over the period is very modest, placing Madagascar at less than 1/10,000 of the world total. The specialisation in applied Biology/Ecology, Earth&Space sciences and medical research is very strong (the IRD estimates based on Pascal give a picture more favourable to medical research). Zooming in to the sub-discipline and given speciality level shows a particular involvement in:

- ecology, environmental studies, zoology (including primatology), plant sciences especially because of the exceptional frequency of endemic flora and fauna on the island, some of them of specific economic interest such as medicinal plants or vanilla. Agriculture as such is not highly represented.
- infectious diseases, public health problems, tropical medicine. Madagascar is also a serious concern for researchers in diseases prevalent in tropical regions for instance malaria, and because of the sometimes dramatic conditions of hygiene leading to hotspots of cholera, plague, and leprosy.
- geosciences (tectonics, seismography, mineralogy).

More than 18% of these publications are in French, a figure much higher than the ISI average. It should be noted that in this set of domestic research, at least 70% involve authors with typically Malagasy names. Other authors include foreign researchers, expatriated scientists in Madagascar as well as Malagasy researchers with non-typical names.

The focus on local health issues and the environmental peculiarities of the island is confirmed by the overlap of [on] and [in] sets, commented on further.

The [by]not[in] row shows the distribution of the diaspora’s production. The scientific interests of the diaspora's scientists are likely to mirror the patterns of their host countries (see below), so that the dispersion of activities is expected to be much larger than for the domestic publications. The profile is relatively flat, except for intense activity in mathematics which is also a strong point of France, the main host country. Furthermore, more than 13% of the publications are in French, a much higher percentage than the average SCISearch value. The column "all" gives the total production of the set of authors based on the restricted list. After applying the correction factor mentioned above, the diaspora's production works out at about 2.5 times the production of domestic research (about 1500 articles vs. 600).

The [on]not[in] measures the attraction of Madagascar as a source of research topics (as mentioned above, the set [on] may however be slightly under-estimated). The proportion of French language papers drops to 6%. In this set we find a very highly concentrated distribution of interests in applied biology/ecology. This concentration is still more conspicuous at the subdiscipline/ speciality level, with a very strong involvement in ecology, focusing on primatology/evolution, plant sciences and geosciences. The pattern is not the same as that for the domestic researchers. The total amount of research on specific Malagasy themes, outside Madagascar, (i.e. articles without any Malagasy address) represents roughly 2,5 times the total domestic research [in] - a figure similar to the diaspora's ratio above.

The next row [on]and[in] shows the overlap between articles on Malagasy themes and domestic research. The ratio [on]and[in]/[in], of about 68%, indicates that quite a large fraction of domestic research addresses specific Malagasy problems - perhaps not short-term societal needs, but at least topics of long-range strategic interest for the island. This reasonably self-centred pattern contrasts with patterns of the poor alignment of science needs found in some country patterns (Arunachalam, 1997, Lewison, 2003). The somewhat surprisingly low value (22%) of the ratio [on]and[in]/[on] indicates that a lot of overseas research on Malagasy topics do not rely on local collaborations (with a dependence on the partner, see §4.2).

Another question one might ask is ‘do expatriated Malagasy researchers keep an interest in typically Malagasy topics?’ The intersection between [by]not[in] and [on]not[in] yields 27 publications, i.e. less than 5% of the [by]not[in] set. Applying the "diaspora" correction, the corresponding number of articles would be about 70. This relatively low figure again can be related to the difference in discipline specialisation between the diaspora and foreign research on typically Malagasy topics.

The picture given by the ISI-WOS shows the modest output of Madagascar and a typical structure for a developing country, particularly of the kind removed from geopolitical ambition which arguably increases defence-oriented science. Efforts are concentrated, at least at a higher level of aggregation, on life sciences, with a focus on applied sub-disciplines. As might be expected the principal areas of visible activity relate to tropical diseases, environmental studies (endemic species, for example), and plant related studies.

4.2 International perspective

Table 2 presents the international composition of the three sets. The column [in] (research in Madagascar) shows the publication profile of countries present in the set. By construction (address-based, presence count) the profile can be interpreted as the profile of international co-authorship of Madagascar. 74,7% of Malagasy publications show an international collaboration. The column [on]not[in] gives the profile of national contributions of research in specific Madagascar-related topics, but not conducted in the country. Roughly, the USA accounts for more than one third of the publications, almost as much as would be expected (on the integer-distinct count), France contributes three times more than the expectation and Germany twice as much. The column [on]and[in] shows the structure of contributions for Malagasy research directed towards

very specific national themes, it can be interpreted as a co-authorship profile. Less than one out of six US publications on Madagascar involves a Malagasy institution, whereas co-publication with Madagascar appears in one third of French publications in the [on] set. The column [by]not[in] shows the national affiliations of articles of authors with the typical Malagasy names matching the extraction profile.

Table 2: International contributions in the sets (integer-distinct count*)

| Set interpretation | [in] copublication profile | [by]** not[in] publication profile | [on] not[in] publication profile | [on]and[in] copublication profile |
|---|---|---|---|---|
| Top ten countries | MDG 596 (100%) | FRA 494 (81,1%) | USA 533 (36,8%) | MDG 409 (100%) |
| | FRA 206 (34,6%) | USA 67 (11,0%) | FRA 255 (17,6%) | FRA 113 (27,6%) |
| | USA 110 (18,5%) | CHE 34 (5,6%) | DEU 211 (14,6%) | USA 93 (22,7%) |
| | DEU 47 (7,9%) | DEU 16 (3,2%) | GBR 145 (10,0%) | DEU 44 (10,8%) |
| | GBR 45 (7,6%) | GBR 16 (3,2%) | ZAF 92 (6,3%) | GBR 32 (7,8%) |
| | ITA 26 (4,4%) | ITA 15 (2,5%) | JPN 61 (4,2%) | ITA 17 (4,2%) |
| | CHE 20 (3,4%) | CAN 11 (1,8%) | ITA 58 (4,0%) | CHE 14 (3,4%) |
| | SEN 20 (3,4%) | ESP 11 (1,8%) | CHE 54 (3,7%) | ZAF 11 (2,7%) |
| | ZAF 16 (2,7%) | BEL 10 (1,6%) | AUS 48 (3,3%) | JPN 9 (2,0%) |
| | JPN 12 (2,0%) | DNK 7 (1,1%) | CAN 31 (2,1%) | SEN 7 (1,7%) |
| | TOTAL 596 | TOTAL 609 | TOTAL 1449 | TOTAL 409 |

* for example, France (FRA) appears on 34,6% of publications of the [in] set.
** on the list A (before application of the correction factor)

The state of dependence of peripheral science is a basic fact. All African countries except the three ‘leaders’ (i.e. South Africa and Egypt and then Nigeria) depend heavily for their publications on collaboration, reaching a level of between 45 and 100% (Rossi, op. cit.). Madagascar has a rather high percentage (75% in our dataset). Strong links with Europe have probably helped to maintain an active network of collaboration. From the opposite perspective, i.e. from the European point of view, the ‘probabilistic affinity’ of France and the UK for research with historically linked regions is high, confirming the role of cultural and linguistic factors in international collaboration (Zitt et al., 2000).

Co-publication is just one form of collaboration amongst many others. More than a hundred inter-university agreements involving Madagascar were recorded in 1999. About 400 Malagasy students complete their education in France each year. Some of them remain in the French academic system which is present on 80% of the identified production of the diaspora.

## V - Discussion and conclusion

In this paper we have tried to combine three representations of the contribution of an ultra-peripheral country to world science: the first one (rather classical), the contribution of domestic research, as generally considered in bibliometric indicators of production; the second measure, related to brain drain and diaspora, a recurrent concern in emerging countries; and the third measure, of particular relevance to Madagascar, considering the territory as a ‘generator’ of specific research topics. We stressed some technical limitations

of the work, which aimed at providing respective magnitudes of the three measures rather than absolutely precise indicators.

The North-South exchange is a complex issue. First North supports South. In the case of the Republic of Madagascar, on the one hand, the academic system is highly dependent on support from the North, either from specific foreign or international organisations. Domestic research in Madagascar is weak in quantitative terms. Moreover, most of the research conducted in the country, at least in that part visible in mainstream journals, is carried out with international collaboration and to a large extent directly funded by foreign or international bodies. It is not clear whether maintaining the flow of collaboration can reduce the tendency to expatriate.

On the other hand, part of the qualified manpower from the South has joined the North, which exerts a 'brain-drain attraction', due to the attraction of better professional, financial and political conditions. The counterpart of the supply of good conditions to a highly skilled manpower is a large collective benefits for the mainstream - the South returns it support to the North. Since the 1960s, the 'brain drain' has been a constant political concern within 'peripheral' countries[6] and has given rise to an extensive literature (see for example Lowell, 2002). For certain large emerging countries, especially in Asia, parts of the diaspora are likely to return, especially with political incentives to turn "brain drain" into "brain gain" (China, India for example). But in most cases (Meyer & Brown, 1999), the countermeasures to prevent the negative effects of the brain drain have largely failed and call for other approaches. In cases where most expatriates are unlikely to return (a settled diaspora), networking of the skills for the benefit of the mother country is a new and promising trend (see Meyer & Brown, op. cit., for a survey of reverse brain Drain experiences). 'Brain-drain' is not the only expression of the free market of skills, Waast for example mentions the hiring of local scientists in international projects and networks.

A sporadic reversal of the 'diaspora effect' has taken place in Madagascar, with at least two prominent individual examples relating to the founders of certain particularly dynamic research structures[7]. However for the bulk of expatriated scientists today, the diaspora effect seems irreversible, due to the inability of Madagascar to provide good scientific working conditions, recognition and an internationally competitive standard of living. We have observed that the Malagasy diaspora is strongly concentrated in France and French-speaking countries. Measured by publication activity, the diaspora's activity is two or three times the total for domestic research.

It should not be forgotten that Madagascar generates many specific research questions in the natural sciences, for example in relation to biodiversity issues, addressed both by local and foreign research. Specific

[6] but not exclusively, see e.g. the program of return of leading UK expatriated scientists (mentioned by Cervantes & Guellec, 2002)

[7] A. Rakoto-Ratsimananga for IMRA, and R. Andriambololona for INSTN. These prominent scientists first worked within CNRS in France - the latter for a short period.

Malagasy research topics feed a flow of publications, out of Madagascar, which is two or three times the total for domestic research (similar to the effect for the diaspora mentioned above). This exchange is mutually beneficial, at least in a long-term perspective, but these publications appear relatively lowly connected to domestic research.

The respective thematic focuses of the three datasets are very different. Domestic research is very much aligned with the local needs (medicine, plant science, but not so much agriculture) but also long-term interests such as bio-diversity. Foreign research on Madagascar focuses mainly on bio-diversity, a world-wide issue of concern, with apparently little attention paid to other topics of national interest. The diaspora's research pattern is even more independent of these local specificities and is more akin to its host country's profile.

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## ANNEX 1 Extraction of the {by} set

**List of frequent typical names (except ambiguous short ones)**

RAFIDY OR RALAIVAO OR RAKOTOBE OR RAZAFY OR RATSIMBA OR ANDRIAMASY OR ANDRIAMALALA OR ANDRIAMANANTENA OR ANDRIAMBELO OR ANDRIANAIVO OR ANDRIANARIVELO OR ANDRIANASOLO OR ANDRIANJAFY OR ANDRIANONY OR ANDRIANTSEHENO OR ANDRIANTSOA OR RABARIJOANA OR RABARIVELO OR RABEMANANJARA OR RABEMANANTSOA OR RABENJAMINA OR RABETOKOTANY OR RADANIELINA OR RAFARALAHY OR RAHARINJANAHARY OR RAHARIJAONA OR RAHARINAIVO OR RAHARINOSY OR RAHARISON OR RAHARIVELO OR RAJAOFERA OR RAJAOFETRA OR RAJAONARIVELO OR RAJAONSON OR RAJOELISON OR RAJOELISOLO OR RAKETAMANGA OR RAKOTOARIMANANA OR RAKOTOMALALA OR RAKOTOMANANA OR RAKOTONDRAZAFY OR RAKOTONIAINA OR RAKOTOSON OR RAMANANTOANINA OR RAMANANTSOA OR RAMAROMANANA OR RAMAROSON OR RAMBELOSON OR RAMIARAMANANA OR RANAIVOJAONA OR RANAIVOSOA OR RANDRIANARISOA OR RANDRIANARIVELO OR RANDRIANANDRASANA OR RANDRIANJAFY OR RASOANAIVO OR RASOAVELO OR RASABOTSY OR RASOLOMANANA OR RATSIMANDRESY OR RATSIMANOHATRA OR RATSIMBAZAFY OR RAVELOMANANA OR RAVELOMANANTSOA OR RAVELONA OR RAVELONANOSY OR RAVELOSON OR RAVOAJANAHARY OR RAZAFIMBELO OR RAZAFINDRAZAKA OR RAZAFINDRAKOTO OR RAZAKAMANTSOA OR RAZANAKOLONA OR RAZANAMASY OR RAZANAMPARANY OR RAMANANA OR RAMPARANY

**Prefix (RA OR ANDRIA) combined with following suffixes:**

AMBELO OR AMPARANY OR ANAIVO OR ANDRASANA OR ANJAFY OR ANTOANINA OR ANTSOA OR ARISOA OR ARIVELO OR BOLOLONA OR DRAITSIORY OR DRAKOTO OR DRAZAKA OR HARISOA OR HARIZAFI OR HEFARISON OR JAHANARY OR JANAHARY OR JOELINA OR JOELISOLO OR JOELISON OR MAHEFA OR MAHOLY OR MALALA OR MANANA OR MANANIVO OR MANANTENA OR MANDREZY OR MIAMPIANINA OR MIHANTA OR MITANDRINA OR NAMASY OR NANDRASANA OR NARISON OR NARIVO OR NIANINA OR NOHATRA OR OARISON OR OZAFY OR RIJAONA OR RIJOANA OR RINOSY OR RIVELO OR TOANINA OR TSIALONINA OR TSIFARITANA OR VOLOLONA OR ZANANORO OR ZANANY

* * *

## ANNEX 2 Temporal features

Global volumes of publication and language in the selected sets

| Pub Year | [in] | [by]* not [in] | [on] not [in] | [on] and [in] | TOTAL | English | French |
|---|---|---|---|---|---|---|---|
| 1991 | 39 | 56 | 83 | 26 | 178 | 83,7 | 14,0 |
| 1992 | 27 | 56 | 75 | 15 | 157 | 86,6 | 12,7 |
| 1993 | 39 | 59 | 90 | 27 | 185 | 86,0 | 12,4 |
| 1994 | 55 | 59 | 103 | 30 | 214 | 88,8 | 11,2 |
| 1995 | 44 | 49 | 125 | 24 | 218 | 89,9 | 8,7 |
| 1996 | 45 | 52 | 131 | 32 | 227 | 91,2 | 7,5 |
| 1997 | 50 | 58 | 138 | 35 | 242 | 90,1 | 9,9 |
| 1998 | 74 | 51 | 168 | 55 | 289 | 83,7 | 14,9 |
| 1999 | 67 | 55 | 185 | 49 | 304 | 88,2 | 10,5 |
| 2000 | 77 | 61 | 181 | 60 | 314 | 91,4 | 8,6 |
| 2001** | 79 | 53 | 170 | 56 | 299 | 91,0 | 9,0 |
| TOTAL | 596 | 609 | 1449 | 409 | 2627 | 88,5% (2324) | 10,7% (281) |

* on the list of specific names (before application of the correction factor)
** provisional data, extracted in July 2002.