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Chapter scientists in the IPCC AR5 — experience and lessons learned

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IPCC Assessment Reports provide timely and accurate information on anthropogenic climate change to policy makers and the public. The reports are written by hundreds of scientists in a voluntary, collaborative effort. Growing amounts of literature and complex procedural and administrative requirements, however, make this effort a substantial management challenge next to a scientific one. During the 5th Assessment Cycle, IPCC Working Groups II and III initiated a program that recruited volunteer scientific assistants who provided technical and logistical support to author teams. In this paper we describe and analyze strengths and weaknesses of this 'Chapter Scientist program', based on an extensive survey among Chapter Scientists (CS) and interviews with other stakeholders. We conclude that the program was a useful innovation that that enabled authors to focus more on their core scientific tasks and that contributed to improving the quality of the assessment. We highly recommend similar programs for future scientific assessments. Key criteria for success that we identified are (a) involvement of early-career scientists as CS, (b) close integration of CS in the assessment process, (c) recruitment of CS through an open call to achieve transparency, and (d) provision of funds for such a program to support travel costs and compensation of CS.

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Introduction

Since 1988, the Intergovernmental Panel on Climate Change (IPCC) has been producing comprehensive scientific assessments on anthropogenic climate change. The Synthesis to the Fifth IPCC Assessment Report (AR5) was finalized in November 2014 [1]. The IPCC's mandate is to assess on a comprehensive, objective, open, and transparent basis the scientific, technical, and socio-economic information on climate change, its impacts, and options for adaptation and mitigation. Hundreds of authors and thousands of reviewers contribute their expertise in this assessment process on a voluntary basis without any form of remuneration [2••]. This massive community effort is supported by a few dozen paid professional scientific and technical staff at the Technical Support Units (TSUs), led by the Co-Chairs of their respective Working Groups (WGs) (see Box 1).

The task to produce comprehensive climate change assessments has become increasingly difficult for a number of reasons. First, the number of peer-reviewed articles on climate change-related topics has increased exponentially over the past three decades [2••,3]. Second, other national and international bodies increasingly publish regional and global environmental assessments and often rely on the same pool of experts [4], putting increasing strain on the scientific community to both produce and assess the science (examples include the U.S. National Climate Assessment [5], the Millennium Ecosystem Assessment [6], the International Assessment of Agricultural Knowledge, Science and Technology for Development [7], the Global Environment Outlook [8], or the Global Biodiversity Outlook [9]). Finally, the IPCC is under high media and public scrutiny, in particular since a few factual errors and inaccuracies were discovered in the WGII Contribution to the Fourth IPCC Assessment Report (AR4) [10–12]. In response to these controversies, the IPCC requested the InterAcademy Council (IAC) to perform an independent review of its processes and procedures [13]. Following the IAC review, the IPCC adopted various changes to its processes and procedures, including a protocol for addressing possible errors [14]. Some of these procedural changes, however, resulted in even higher workloads for those involved in preparing the assessments.

Recognizing the need for assistance to the senior scientists who write the IPCC Assessments on a voluntary basis and next to their daily jobs, WGs II and III started a

Box 1 The IPCC writing process in AR5 in a nutshell.

Abbreviations

AR	Assessment Report
CLA	Coordinating Lead Author
CS	Chapter Scientist(s)
IPCC	Intergovernmental Panel on Climate Change
TSU	Technical Support Unit
WG	Working Group

IPCC reports consist of individual contributions from three Working Groups (WGs) and a Synthesis Report. Each WG contribution consists of multiple chapters, which are developed by teams of senior scientists under guidance of the WG Co-Chairs. Chapter teams (Figure 1, blue box) are comprised of two or three Coordinating Lead Authors (CLAs) and a team of Lead Authors, who are responsible for developing the chapter's content, and two to four Review Editors, who are responsible for ensuring the integrity of the review process. The Fifth IPCC Assessment Report (AR5) was developed by more than 830 authors and Review Editors from 85 countries (www.ipcc.ch/activities/activities.shtml). These authors and Review Editors are almost exclusively senior scientists, who invest a significant share of their time producing and revising the drafts.

Expert reviewers provide comments on First and Second Order Drafts and governments provide comments on Second Order Drafts. In AR5, thousands of reviewers submitted over 136,000 comments — chapter teams need to provide a written response to each of those. Contributing Authors provide input on specific topics on invitation by chapter teams. Staff at the Technical Support Units (TSUs) (Figure 1, orange box) and the IPCC Secretariat (not shown in the figure) provide operational and scientific support. In AR5, WG II and WG III formally introduced the role of Chapter Scientists (CS). Chapter Scientists were de facto members of the TSU, although they continued working from their home institutions, and supported specific chapter teams.

unique experiment during the AR5 cycle: they organized a pool of volunteer assistants, consisting mainly of early-career scientists. These *Chapter Scientists*[5] assisted chapter teams with technical aspects of chapter development, including cross-checking between findings presented in different parts of the report, additional fact-checking, and reference management.

In this paper, we describe the setup and analyze strengths and weaknesses of this experiment, which we will call the 'Chapter Scientist Program' hereafter. The analysis is based on (i) a survey among Chapter Scientists (CS) who participated in AR5, (ii) interviews with TSU staff and IPCC authors, and (iii) our personal experiences while working as CS in AR5. Based on the results we formulate recommendations for the involvement of scientific assistants in future IPCC and similar scientific assessments.

[5] WG III used the term 'Chapter Science Assistants', WG II used 'Volunteer Chapter Scientists'. For simplicity, we simply refer to 'Chapter Scientists' throughout this paper.

Setup of the WGII and WGIII chapter scientist program

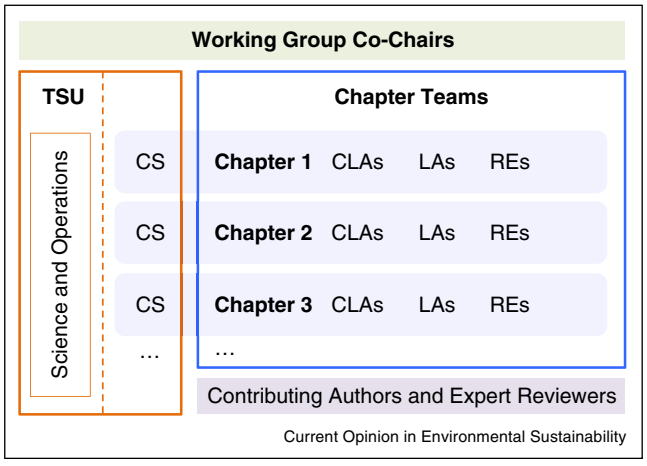
The CS program implemented by WGs II and III aimed to provide increased technical support to any chapter team who wanted it, independent of the resources of individual authors. In previous IPCC assessments, such support was only available to authors through their own grants or government assistance, introducing some degree of inequality between chapters. The CS program also provided young scientists the opportunity to become involved in the IPCC process, regardless of a previous affiliation with an IPCC author.

Chapter Scientists were recruited in two ways. Firstly, the TSUs issued an open call for applications for the CS position. The call advertised a volunteer, that is, unpaid, position that would require applicants to dedicate at least 1/3 full time equivalent over a 2.5-year period while working from their home institutions, and offered no remuneration other than '*the opportunity to be involved in the IPCC process*' (Personal communication, WGII TSU on 10-09-2014). The TSUs selected applicants based on expertise, motivation, time availability, and experience in working in a multi-cultural context, while efforts were made to ensure regional and gender balance. Secondly, several Coordinating Lead Authors (CLAs) with access to funding (e.g., from their national governments or research departments) hired scientific assistants directly. Those assistants thus had paid positions but yet they became part of the formal, TSU-coordinated CS program.

Most applicants in the open call expressed strong interest in working with a certain chapter, and were matched accordingly if possible. Formally, however, CS, whether hired directly by chapter CLAs or through the TSUs' open calls, were not part of a chapter team, but became de facto members of the TSUs and reported to the TSU executive director. According to the Terms of References (TORs), the CS' role was to support chapter teams with technical aspects of chapter development, including cross-checking between findings presented in different parts of the report, additional fact-checking, reference management, and assistance with figures and tables (see Section *Tasks and Workload* for further details). WG II was able to ensure funding for travel expenses from various sources, which allowed all WGII CS to attend Lead Author Meetings irrespective of whether they could receive travel funding through their home institutions (which was usually the case for those CS hired directly by CLAs).

WG I did not to introduce a CS program, for a number of reasons, including potential conflicts with IPCC principles and procedures, and concerns regarding issues of balance, equity, transparency, confidentiality, impartiality, and others. Nevertheless, at least one-third of the

Figure 1



Schematic representation of the scientific contribution to an IPCC report. Chapter Scientists are specific to WGs II and III in AR5. TSU: Technical Support Unit, CLA: Coordinating Lead Author, LA: Lead Author, RE: Review Editor, CS: Chapter Scientist(s).

WGI CLAs had one or several assistants who supported their work as CLA during the AR5 cycle.[6]

Evaluation of the chapter scientist program

In this section, we summarize results of an online survey that was sent to all WGII and WGIII CS in August 2014. 24 out of 36 WGII CS (67%) and 14 out of 23 WGIII CS (61%) completed the survey.

Demography of the chapter scientist group

Two-thirds (66%) of the survey respondents were paid for their work as CS either full-time or part-time, and one-third (34%) of the respondents worked on a voluntary basis. Chapter Scientists with a paid position were generally recruited through their CLA or through a vacancy rather than through the TSUs' open call (Figure 2a) and were generally based at the same institute as their CLA (Figure 2b). Funding for these positions came from diverse sources, such as national governments, research grants, fellowships, or university departments. Voluntary CS were generally recruited through the TSUs' open call and were generally *not* based at the same institute as one of their chapter team's members.

When starting their position, most CS were MSc or PhD students or early career scientists (Figure 2c) and younger than 35 years (data not shown). Two-thirds of the CS were female (data not shown). The majority of the CS (75%) came from developed countries (Figure 2d), mostly from World Meteorological Organization (WMO) regions VI (Europe) and IV (North America, Central America, and Caribbean) (Figure 2e). However, voluntary CS more often came from developing countries and countries with economies in transition than paid CS (54% of the voluntary CS vs. only 8% of the paid CS came from developing countries or countries with economies in transition; Figure 2d). The group of voluntary CS also exhibited better regional balance, with almost equal distribution over four out of the six WMO regions (Figure 2e).

Tasks and workload

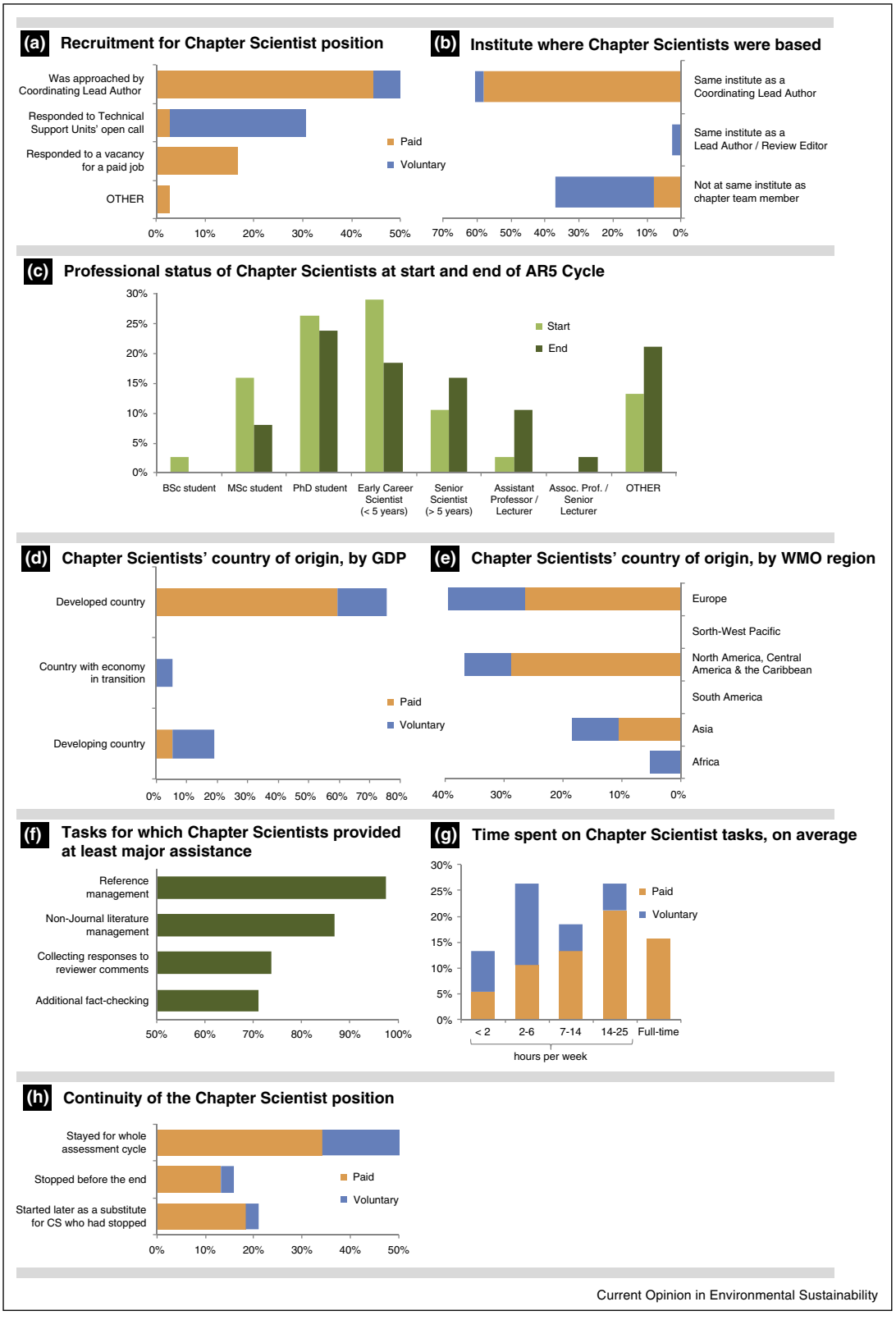
Virtually all CS (97%) provided major assistance with or were the principal person in charge of reference management (Figure 2f). Other main tasks of CS were non-journal literature management, collecting and compiling responses to reviewer comments, and additional fact-checking of all numerical statements presented in the drafts (Figure 2f). However, the role of CS also extended to managerial and coordinative tasks. About one-third of the CS assisted with document management, copy-editing text and version control. Chapter Scientists also supported the process by sending out reminders, developing time-lines for submission, following up with authors, and arranging chapter team meetings and calls.

Weekly workload varied widely across the group, and between voluntary and paid CS. About two-thirds of the voluntary CS spent on average less than 6 hours per week on their CS tasks, while 56% of the paid CS spent 14–25 hours or more (Figure 2g). Chapter Scientists mention the high and temporally unevenly distributed workload, inherent to the IPCC process with a tight schedule and strict deadlines, as the most important difficulty that they encountered in their work. Several CS found that the workload was higher than they had expected. Only a small share of CS (16%) performed this task as a full-time job (Figure 2g), but several CS report having to work full-time when a deadline was approaching, which made it difficult for them to balance their CS tasks with other obligations.

Only about two-thirds of the respondents stayed on for the whole assessment cycle. Several CS left their position before the end of the assessment cycle (Figure 2h), usually because they moved to a new position. This led to problems with continuity, as it required some time for new CS to become acquainted with the tasks and complex IPCC processes (Personal communication, WGIII TSU on 04-09-2014). 85% of the voluntary CS versus 50% of paid CS stayed on for the whole process, showing that paid positions are no guarantee for continuity.

[6] In September 2014, we sent e-mails to all 29 WGI AR5 CLAs, asking them to identify scientific assistants who had supported their work as CLA during the AR5 cycle. 19 CLAs (66%) replied, of which 11 (58% of respondents or 38% of all CLAs) stated to have had one or several assistants in their role as CLA. In total, we received names and contact details of 16 assistants. Those Assistants were also surveyed (9 out of 16 replied), however, their answers are not included in the analysis due to the fundamentally different organization in WGI.

Figure 2



Graphs showing selected quantitative results from the survey among WGII and WGIII Chapter Scientists ($n = 38$).

Motivation and learning experience

The possibility to network and interact with the international climate science community is frequently mentioned as the most rewarding aspect of the CS position by the survey respondents. Respondents also appreciated the opportunity to gain insights into the assessment process at the science-policy interface. Many CS had a strong intrinsic motivation to contribute to the IPCC process as they felt they were making a contribution to something of large societal importance. As one of the CS put it: ''*I felt that volunteering my time to the IPCC was a worthwhile endeavor, a service to the field and society.*''

While the task description in the open call clearly emphasized the supportive role in technical tasks, many CS mention 'engaging and increasing knowledge in a new topic or field' as a major motivation to apply for the position. Indeed, several CS state that they became involved in content-related tasks, and about one-third served as a Contributing Author. Some CS (generally Postdocs or Senior Scientists), however, report to be disappointed that they were not given the opportunity to be more involved in content-related tasks.

Satisfaction and integration in the process

Overall, satisfaction with the program among CS was very high. More than 80% of the CS rate their overall experience as 'positive' or 'highly positive'. The majority felt well integrated in the process and highly appreciated the cooperation with the chapter team and TSU. Many CS described their role as that of a logistical and editorial assistant who kept an eye on internal deadlines and brought different parts of the chapter together. Several CS, however, stated that their role should have been better defined, as their responsibilities were not always clear. As both WG II and WG III provided detailed TORs describing the role and tasks of the CS, this was likely a result of insufficient communication between TSU, CS and/or chapter teams (e.g., authors might not have been aware of the TORs for CS).

Almost 80% of the CS participated in Lead Author Meetings (15% state that they could not participate as there was no funding to cover their travel expenses[7]). Participation in Lead Author Meetings allowed CS to get to know the members of their chapter team in person, and to closely follow the discussions on the chapter and the report in general, greatly enhancing their feeling of involvement. In addition, CS could share experiences and successful practices with other CS. Participation in Lead Author Meetings is frequently mentioned in the survey as one of the most rewarding aspects of the CS position, and is a prerequisite for several other aspects that CS found rewarding (such as meeting and networking with other scientists and experiencing the IPCC process first hand). Participation in Lead Author Meetings was thus crucial for the motivation of CS, and contributed to their successful work.

Discussion and recommendations

Participating in an IPCC assessment puts a high workload on authors on top of their regular jobs. In previous IPCC assessments (and in WG I during the AR5 process) dedicated assistance was author-specific and limited to authors who had access to funding through their governments or research departments (and thus usually to authors from developed countries). The WGII and WGIII CS program in AR5 aimed at providing much-needed support to *every* author team by involving early-career scientists as volunteer assistants in the process.

The need for dedicated author assistance is evident: In a recent survey among all AR5 WGI authors and Review Editors, about 80% of respondents agreed that (i) the amount of literature to be assessed for an IPCC report was a challenge and (ii) that dedicated assistance to CLAs should be a standard approach in future IPCC assessments [2••].

Authors were highly appreciative of the CS and their work (Box 2). Both CLAs and the TSUs state that having an intermediate person who could focus on technical, logistical, and managerial tasks was one of the outstanding assets of the program. Chapter Scientists were able to take on tasks that do not require the level of expertise of CLAs and Lead Authors, thereby freeing up the authors' time to work on the core scientific assessment. Chapter Scientists also helped to resolve some of the logistical issues arising from the diverse geographic composition of author teams (e.g., assisting with access to literature, setting up online meetings). For the TSU, CS were a clear contact point for questions regarding technical aspects of chapter development, which made the process more efficient.

The CS program provided an opportunity for early-career scientists to become involved in the IPCC process, thereby contributing to the capacity-building of a new generation of scientists. Chapter Scientists were highly satisfied with the program and benefitted from the opportunity to be involved in the IPCC process in multiple ways (for example, increasing their network and gaining experience in project management). Others have pointed out that actively involving young talent, for example as expert reviewers, can strengthen the IPCC process, while offering young scientists the opportunity to learn from participation in a key scientific activity [15••].

While the CS program in AR5 was in principle set up as a volunteer program (the TSUs did not offer any financial remuneration), about two thirds of the respondents in our

[7] Remarkably, half of the respondents who stated that lack of funding prevented them from participating in Lead Author meetings were WGII CS, even though WG II in principle ensured that all CS had access to travel funding, either via CLA-sourced grants or other funds.

Box 2 Views on the Chapter Scientist Program from TSUs and CLAs.

'In my opinion, the AR5 Chapter Scientist program was an excellent, well thought out and extremely useful innovation. I highly recommend keeping this service alive through next assessment reports. The support our Chapter Scientist provided on literature searches, sending follow-up mails, collating texts received simultaneously from multiple sources, meticulous consistency checks, and improvement of graphical presentations came as a major value addition which I can say has improved the chapter output quality tremendously. Chapter Scientists support CLAs in managing the process efficiently and effectively, with less stress.'

(Joyashree Roy, CLA Chapter 10, WG III)

'From my point of view, the Chapter Scientists' work was indeed very precious and enabled us as CLAs to achieve much better and profounder results. Especially many of the detailed checks necessary for an exhaustive use of the available literature, but also for adequate responses to reviewers' comments, would not have been possible without their support.'

(Josef Settele, CLA Chapter 04, WG II)

'This program was a great success. Many authors told me that they would not have managed to produce the quality report they did without the brilliant support of their Chapter Scientist.'

(Steffen Brunner, WG III TSU)

'In times of exponentially growing scientific literature, assessments such as that of the IPCC require huge amounts of networking — chapter scientists can do miracles that way.'

(Wolfgang Cramer, CLA Chapter 18, WG II)

'The Chapter Scientist program was helpful for the CLAs and the author team. This was also good for the young researchers' capacity building.'

(Shobhakar Dhakal, CLA Chapter 12, WG III)

'What I have experienced over the past years while working with Chapter Scientists on AR5 was extremely positive. Our Chapter Scientist's excellent work complements our achievement. I highly commend the Chapter Scientist Program.'

(Oliver C. Ruppel, CLA Chapter 22, WG II)

survey were actually paid for their work as CS. Funding for these positions came from various sources and was independent from the TSU CS program. Yet these assistants benefitted from being part of the centrally coordinated TSU program, as it increased their integration and participation in the assessment process. This also becomes evident from the survey responses from the scientific assistants to CLAs in WG I (where no CS program was in place). Five out of the nine assistants to WGI CLAs in AR5 who filled in our survey express that they would have liked to be more integrated in the process (e.g., through closer connection to TSU and chapter authors, and the possibility to participate in Lead Author Meetings).

The CS program in AR5 was greatly appreciated by authors, the TSUs and the CS. Based on the survey results and our own experience, we formulate recommendations for future involvement of CS in IPCC and similar assessments below.

First, it is important to recruit CS with a background in the relevant scientific discipline. However, recruiting mid-career scientists for a job that potentially involves little content-related work bears the risk that they leave their posts for other opportunities. Continuity may be achieved by recruiting early-career scientists (graduate students or recent graduates) with a dedicated interest in science management, for whom the position may be more rewarding in the long term.

Second, integration of CS into the assessment process is crucial for the motivation and effectiveness of CS. Good integration can be ensured through (i) a clear definition of the role of the CS in the TOR, (ii) a clear communication of the role of the CS to all members of the chapter teams early in the process, (iii) central coordination of the CS program through the TSUs and integration of the CS into communications by the TSU to the chapter teams, and (iv) the possibility for CS to attend Lead Author Meetings.

Third, recruiting CS through an open call by each WG increases the transparency of the process and opens the opportunity to young scientists who otherwise would not have the chance to participate. Our survey results show that in AR5 recruitment of CS through an open call achieved higher participation of scientists from developing countries and countries with economies in transition compared to recruitment of CS through CLAs. The TSUs could lead recruitment with an open call for the CS positions, with the possibility for the CLAs to be involved in the selection process in order to ensure a good working relationship.

Fourth, sufficient funding for a future CS program should be ensured. Funding should at least cover CS travel to Lead Author Meetings, but ideally provide salaries for full-time or part-time assistant positions for all CLAs. In AR5, there was a mix of CS who were paid for their work and CS who performed this task without financial remuneration. The advantage of recruiting voluntary CS was that WGs II and III could make CS available to *all* chapters, even in absence of structural funding for author assistance. This led to more equality across chapters in terms of technical support, however, some inequality persisted as our survey results show that CS with a paid position were able to spend substantially more time on their chapter work and thus to provide support at a more consistent and profound level. Funding for a scientific assistant for IPCC authors was also recently demanded by the WGI Co-Chair and the Head of the WGI TSU [2••], though they leave open where such funds could come from. A review of the IPCC assessment by the Dutch government suggested that IPCC governments should provide funds for assistants to support quality control [10]. Alternatively, funding for the CS program could come from various sources, such as science funding foundations, provided that no conflict of interests arises.

At the time of writing this paper, other international assessments are starting to involve volunteer assistants as well. In May 2015, the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) announced a pilot fellow program that will enable young scientists to become part of the work of IPBES [16,17•]. The IPBES fellow program is similar to the IPCC CS program in many aspects. While the IPCC CS program emphasized the role of CS in technical support and quality control, however, IPBES fellows have clear content-related responsibilities and will act as ''contributing authors'' to their chapter [17•].

Conclusions

The IPCC CS program proved to be a highly successful and very helpful support for the writing process of the IPCC AR5, one of the largest, global-scale, comprehensive, collaborative efforts in science. The experiences of the CS, authors, and the TSUs help to inform future IPCC assessments and other similar endeavors, such as the recently started IPBES. We highly recommend the involvement of early-career scientists in such an author support program in general. Key criteria for success that we identified include (a) involvement of early-career scientists as CS, (b) close integration of CS in the assessment process, (c) recruitment of CS through an open and widely advertised call to achieve transparency, and (d) provision of funds for such a program to support travel costs and (ideally) salaries of CS.

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- • of special interest
- •• of outstanding interest

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In this paper, the Co-Chair and the Head of the TSU of IPCC Working Group I reflect on possible innovations to the IPCC process, based on their own experience and a survey conducted among WGI authors and Review Editors. They emphasise the growing burden on IPCC authors and call for a longer assessment cycle and institutionalised support for authors.

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Van der Veer *et al*. describe an experiment initiated by the Dutch government that recruited PhD students to support the government review of the WGII contribution to the AR5. Based on their experiences they formulate recommendations for crowdsourcing young talent to enhance the quality and transparency of the IPCC assessment process.

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This document describes the terms of references for the IPBES fellow program, which in many respects is similar to the IPCC Chapter Scientist program.