



Aims

The aim of our topic this year is to draw connections between food security, biodiversity and bioenergy and to use the meetings to think about the research pathways that will help us to prepare for and address the challenges we will face in the future.

This is the third meeting in the series and this month, the three witnesses will help us to think about the kinds of data sets we can use to look at land use and land use change and links between these and policy implementation.

Agenda

All the witnesses will give a 10 minute introduction and their perspective on the two core questions followed a general discussion:

- 5:00pm Welcome by the Chair and an introduction to the topic
Each witness gives a short introduction and thoughts about the questions (10 mins)
Questions and beginning the open discussion
- 6:00pm Coffee break
Continue the discussion in three groups and then come together for final thoughts
- 7:15pm Reception and dinner, which will include a working session

Witnesses

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| Dr Alan Belward | Head of the Land Resource Management Unit at the Institute for Environment and Sustainability, European Commission's Joint Research Center (JRC) in Ispra, Italy |
| Dr Jon Hutton | Director of the United Nations Environment Programme World Conservation Monitoring Centre in Cambridge |
| Dr Lucas Joppa | Head the Conservation Science Research Unit and a scientist in the eScience Group at Microsoft Research, based at the Microsoft Redmond Campus, USA |

Questions

This month, the witnesses have all been asked two core questions:

- 1) What do you perceive as being the main gaps in our knowledge?
- 2) What would you include in the 'next generation' of research questions?

Each of these questions will be posed to everyone and their answers will then be used as a springboard for further discussion. The main points raised will then sent to everyone to use as a starting point for the next meeting.

Witnesses

Dr Alan Belward

Head of the Land Resource Management Unit at the Institute for Environment and Sustainability, European Commission's Joint Research Center (JRC) in Ispra, Italy

Alan Belward leads one of eight Units within JRC, which provides information for European and International policies aiming to balance competing land-use demands whilst securing access to natural resources and maintaining ecosystem services.

He received the BSc degree in Plant Biology from the University of Newcastle upon Tyne in 1981, and MPhil and PhD degrees in remote sensing studies of vegetation, both from Cranfield University's School of Agriculture Food and Environment in 1986 and 1993 respectively. In the 1990s he co-chaired the International Geosphere Biosphere Programme's Land Cover Working Group and chaired the Committee for Earth Observing Satellites (CEOS) Working Group on Calibration and Validation. From 2002 to 2006 he chaired the Global Climate Observing System's (GCOS) Terrestrial Panel and in 2009 he was appointed to the GCOS Steering Committee. He is a member of the NASA and USGS Landsat Data Continuity Mission Science Team and the European Space Agency's Sentinel-2 Mission Advisory Group and is also a visiting lecturer at the Technical University of Vienna.

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Dr Jon Hutton

Director of the United Nations Environment Programme World Conservation Monitoring Centre in Cambridge

Jon Hutton received a doctorate in crocodile ecology from the University of Zimbabwe in 1984. During the next 20 years he held a number of senior management positions in that country, encompassing the government, NGO and private sectors. During the early 1990s he was one of the Zimbabwe Government's negotiators to the biodiversity-related Multilateral Environmental Agreements.

In 1999, he moved to Europe to work as the Executive Director of Resource Africa and Fauna & Flora International's Director for Africa before joining UNEP. Jon has produced over 50 papers, books and conference proceedings covering issues such as conservation policy; wildlife management; protected area management; community-based natural resource management; the sustainable use of natural resources; and the relationship between conservation and poverty. In recognition of his academic interests he was appointed a Senior Member of Hughes Hall College, Cambridge in 2004 and Honorary Professor of Sustainable Resource Management at the University of Kent in 2007.

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Dr Lucas Joppa

Head the Conservation Science Research Unit and a scientist in the eScience Group at Microsoft Research, based at the Microsoft Redmond Campus, USA

Lucas Joppa's research combines science, policy, and tools & technology. This ranges from quantifying the impacts of conservation actions to unraveling the complexities of species interactions and mapping where species are being discovered - and going extinct. He embraces the challenge of predicting outcomes for ecological communities under an increasingly uncertain environment, and unite robust ecological theory, social considerations, and innovative distributed data collection systems to achieve effective environmental conservation.

He completed his PhD in Ecology from Duke University's Nicholas School of the Environment. He is currently an Honorary Research Fellow at the University of Kent's Durrell Institute for Conservation and Ecology (DICE) and an Honorary Conservation Fellow at the Zoological Society of London (ZSL). In 2013, he received the Society for Conservation Biology's 'Early Career Award'.

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Transcript

Duration: 1:45:45

Forum Members

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|------------------------|
| Alan Belward (AB) |
| Alison Smith (AS) |
| Elena Kazamia (EK) |
| Gemma Cranston (GC) |
| Ian Hodge (IH) |
| Jon Hutton (JH) |
| Kristen MacAskill (KM) |
| Lucas Joppa (LJ) |
| Martin Rees (MR1) |
| Mike Rands (MR2) |

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| Miles Parker (MP) |
| Moira Faul (MF) |
| Paul Linden (PL) |
| Rosamunde Almond (RA) |
| Susan Owens (SO) |
| Therese Rudebeck (TR) |
| Will Simonsen (WS) |
| Howard Griffiths (HG) |
| Richard Fraser (RF) |

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| MR1: | Thank you Roz for looking up what is a very nice place to meet and a special welcome to Alan, to Jon and to Lucas as our three witnesses. I should explain to our newcomers that we have 10 minutes [inaudible 0:00:36] afterwards and then [inaudible 0:00:42] for about an hour, then we have a short coffee break and then we reconvene in two separate groups. [inaudible 0:00:53]. Thank you very much. But for the benefit of our witnesses and other new people it might be a good idea to go round the table again very briefly and for everyone to say a sentence about themselves [inaudible 0:01:06] to this gathering. |
| EK: | I'm Elena Kazamia and I'm a postdoctoral researcher with [inaudible 0:01:20]. |
| MR2: | I'm Mike Rands, I'm the Director for the Cambridge Conservation Initiative, an operation between the University and a cluster of conservation organisations based in and around Cambridge. [inaudible 0:01:36]. |
| AS: | I'm Alison Smith from Plant Sciences. I'm a biochemist but I am interested in algal biotechnology and bioenergy. |
| PL: | I'm Paul Linden, I'm an applied mathematician working on [inaudible 0:01:50]. |
| IH: | I'm Ian Hodge, I'm from the Department of Land Economy. I'm a rural economist with interests in property, institutions, land, rural environmental issues, agricultural policy. |
| RF: | I'm Richard Fraser from the Department of Social Anthropology. I'm working on a project on land use change and climate change across Inner Asia, particularly China and Mongolia. |
| SO: | I'm Susan Owens, Department of Geography. I'm interested in environmental governance and especially with the relationship between what we know and what we do. |
| MR1: | I think [inaudible 0:02:34], straight from the horse's mouth as it were. |
| LJ: | So I'm Lucas Joppa, I'm a scientist at Microsoft Research, formerly just up the road at 21 Station Road for the past five years and then three months ago we moved it back to Seattle. My background is in all sorts of conservation related questions particularly around the impact of conservation interventions, assessing species extinction rates and, you know, do we know anything about it? |
| AB: | I'm Alan Belward and I work for the European Commission but not in Brussels. I work at the Joint Research Centre in Ispra in northern Italy and I'm Head of the Land Resource Management Group there in the Institute for Environment and Sustainability and it's all about the competition for land and how that helps commission policy and development |



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| | and climate change and environment directorates. |
| JH: | I'm Jon Hutton, I work for UNEF as the Director of the World Conservation and Monitoring Centre and my speciality was crocodile ecology and management which is very useful when you work for the UN, I can assure you! |
| MF: | I'm Moira Faul, I work at the Centre for Science and Policy and the Humanitarian Centre. |
| HG: | Howard Griffiths in Plant Sciences and also Co-chair of the Global Food Security Initiative. |
| WS: | Will Simonsen, I'm in the Forest Ecology and Conservation Group in Plant Sciences where I've been using remote sensing technologies study forests, but I am in the New Year moving into a new area of global food security as a coordinator of the [inaudible 0:04:21]. |
| TR: | My name is Therese Rudebeck and I'm a PhD student under Susan Owens and Keith Richards in the Geography Department and I study global water governance. |
| KM: | I'm Kristen MacAskill, I'm a civil engineer and based at the Centre for Sustainable Development in the Engineering Department. I'm currently filling in for my supervisor Professor Peter Guthrie and my research is around post-disaster urban reconstruction [inaudible 0:04:47]. |
| GC: | Hi, I'm Gemma Cranston, I work for the Cambridge Institute for Sustainability Leadership specifically in the Natural Capital Leaders Platform. |
| RA: | Hi, I'm Roz, I'm a conservation biologist by background, I'm based with Paul in Mathematics and for the last couple of years I've been helping to bring together the Forum with Martin and Paul. |
| MR1: | Hello, and Miles if you could introduce yourself? |
| MP: | Last man in! My name is Miles Parker, formerly Director of Science and Deputy Chief Scientific Adviser at DEFRA and I'm now with the Centre for Science and Policy here. |
| MR1: | Thank you very much. So have you decided what order you're going to speak in? |
| AB: | No. |
| JH: | Yes, you're going first. |
| MR1: | So definitely alphabetical, so shall we go alphabetically then? |
| AB: | I think it's just been decided so I'll start. It is a delight to be here. When I looked at the website that Roz gave me the links to and I saw what you are looking at, this nexus between food security and energy and biodiversity it resonated so strongly with what we're trying to do in the Commission. Let me rephrase that, in the Joint Research Centre supporting the Commission or advising the Commission. What we do is provide scientific evidence to the policy makers, what they do with it is another matter and the group on land resource management it really is all about the competition for land, that's what we're looking at, and we're looking at whether the land is used for fuel or whether it's used for biodiversity or whether it's used...if we're looking at [inaudible 0:06:38] it's all about carbon sinks, with the biodiversity people it's about reaching the Aichi targets for the Convention on Biological Diversity or else it's the land degradation targets for the Convention to Combat Desertification, so it's that sort of nexus that we're looking at. There is a common message that we keep passing to these people and that's that land is finite, we don't make any more of it, that it's non-renewable and that's an important one for us which is the notion that we keep reminding them it takes 100 years for a centimetre of soil to form and so what you've got in temperate grasslands that is about the right timescale. So what you've got you'd better use it carefully and it's scarce and that's one of the issues in terms of a lack of knowledge is just what is the distribution of the naturally fertile soils of the world? We estimate it between 13% and 18% but that's a huge range so there is great uncertainty, it's also very small as a number. So again we say whatever |



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| | <p>you're going to do with it be careful. I know you've done a lot on urbanisation and that's one issue that is very big for us is the notion of land take and we calculated something like a thousand square kilometres of land at the European Union are lost to urban expansion every year - that's eight Cambridges to put it into perspective, every year, so it's a lot of land that is going.</p> |
| | <p>We keep coming up against the fact that we just don't have information on land cover - is it urban or is it forest or is it grassland or is it agriculture? So land cover is a big gap. Land use, if it's forest or if it's agriculture, is the forest used for timber, is it used for pulp, is it used for firewood fuel, is it used for charcoal? So there's those sort of issues that go with that choice. Then a third one is the actual cadastre, each of those pockets of land who owns it, what is the actual boundary of it? And that's a very significant factor in all of the work that we do because you need that traceability. So we have to come back to on a national scale, or in our case the pan-European dimension, it is looking at for policy implementation we want to know what's the land cover, how is it changing and what specific parcels are being changed? If you look at how the agricultural policy is implemented the farmer has to maintain the land in good environmental condition, that is tracked to a specific parcel of land so it's all connected up and we rely very heavily on the view from above for all of this work. So my background is in satellite remote sensing. We started with the aerial photography from 1858, the balloonist with Gaspard-Félix, Nadar was his nickname wasn't it?</p> |
| PL: | I promise I wasn't there! |
| AB: | <p>We then went from balloons to...my favourite which is the Bavarian Pigeon Corps of 1903, I just love that, the little clockwork cameras on the pigeons, and then the satellites and the satellites, the numbers are just changing so rapidly and I think that there are maybe three processes that are going on though. One thing that we've really noticed is you could maybe say a democratisation of space. It used to be that the capacity to look at global land was in the hands of the US, in 1972 they were the only ones flying a global land imaging satellite. Then it was the US and Russia, US, Russia, China, then it was US, Russia, China, India, Europe, but in the last 10 years that picture has changed dramatically and there are now all sorts of countries flying these satellites. The resolution has changed dramatically as well. In the 1970s the best you could get was about 80 m and as of this summer the best you can get is 31 cm. Wow! From space. That's changed and even that...</p> |
| MR1: | Open civilian data. |
| AB: | <p>Open civilian data. Until June of this year the US government put an embargo of 50 cm on, they wouldn't allow anybody to mark it and [inaudible 0:10:58] finer than that, but they lifted that in June of this summer so you can go down to 25 cm, no one's got that at the moment but the WorldView-3 is 31 cm so we're getting very close to it. For me...so that was one policy decision that's made that's affected us enormously and the one that's really affected us though was the full free and open access to the archives. I mean we've had satellites flying for 42 years which are measuring land coverage scales which are useful for the sort of decision-making process but the data were pretty inaccessible. Then in 2008 when policy decision was changed to full free and open then it just mushroomed. The US now, the USGS, the EROS datacentre distributes as much in a day as it ever did in a year when it was being sold, I mean it's just expanded enormously and what that's meant is that we can do a lot of new things because we've got access to data in volumes that we would just never have... I mean it used to sell for, what for...the cheapest it was ever sold for was \$600 a scene, when it was commercial it was \$3,000 a scene. Last week we analysed 144,000 scenes in one go to produce a global surface water map. This was just unthinkable even a year ago. So we've got full free and open access to the data, so the data are flowing and that I think is leading us to new products, new things coming in online. Then of course things like the global water map at 30 m resolution opens a whole series of new doors as well, you're starting to do things with that that you would</p> |

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| | never have been able to do before. We've got permanent water, seasonal water, ephemeral water; you can pick up dams where hydroelectric dams have been installed or where they've been taken away and you can map this stuff for the first time globally. |
| | Then we start layering it up with Jon's information on protected areas and species and start being able to look at gaps like that. I think in terms of gaps in knowledge for sure we've got the data and the data are flowing but we're not turning it into useful maps and measurements for the modelling community yet, there is still too big a gap there. |
| | I think that collectively when I look at the observations that are being touted for climate, for biodiversity, for desertification, we could get a lot of traction by looking at commonality and no one's done that yet and there are essential climate variables out there, there are essential biodiversity variables, there are desertification indicators but nobody has looked at how they cross and I think we could get a lot of traction if we did that. |
| | I think there's still a gap in terms of translating policy goals into observable measurements. So if you look at the Rio+20 commitment to a land degradation neutral world, great statement but what's land degradation neutrality? How do you measure it? How do you measure it reliably, quantitatively and in a process that's comparable from one area of the world to another? So there's a bit of a gap there. |
| | Then in terms of the specifics what it comes down to to me is big data and it's managing the data flows. I mean last week...we couldn't have done it without Google Earth Engine... |
| LJ: | You could have, but... |
| AB: | But we did it, we did it with Google Earth Engine and we processed 144,000 Landsat scenes in eight hours, we put it on 20,000 CPUs and it just went, we could never have done that and it's changing the way in which we work with the data completely. Because you can try something, it doesn't work, fix the algorithm, run it again and that's on the global scale that we've never been able to do before. So suddenly you're confronted by lava flows in parts of the world or high mountains, low sun angles for a whole year's data. And the satellites that are just about to be launched by Europe, the data flows are going to be enormous. The first one went up in April of this year, Sentinel-1, Sentinel-2 is going to go up at the end of this year. 2 TB a day and that's just the raw data, then you've got to turn it into a surface reflectance so you're doubling it. Then you've got to put it all together to analyse it and I think that's maybe where other witnesses have got more to say than me. So I think I'll stop there as the final statement. |
| MR1: | Thank you very much indeed. Any questions for Alan? |
| PL: | So is the global coverage uniform? |
| AB: | No it's not. It's getting much more uniform. It's a bigger problem when you go back in time because when you go back...I mean I say globally Landsats have been flying since 1972, over the US you've got a consistent, repeatable archive because of all the [inaudible 0:16:11] receiving station there. If you look at Central Africa there are many years where it's a huge data hole, there was no receiving station, there was no on-board recording, there was nobody bothering to archive the data and so you've got a very spotty sample when you go back in time. Again the new programme is really improving things enormously and the Landsat that was launched last year they acquire every image every day, so it's far more uniform. Then you've got the issues of cloud cover and stuff but essentially, no, it's not uniform at that resolution, other ones are. |
| MR1: | So what wavebands do you use? |
| AB: | Visible, near-infrared and short-wave infrared primarily. |
| SO: | [inaudible 0:17:03] Do you have questions for the samples for which you then look for the data to analyse or do you collect lots of data [inaudible 0:17:21]. I mean it sounds trivial |



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| | but [inaudible 0:17:28]. |
| AB: | Well it's a little bit of both. I mean to be honest nobody asked us to map global water at 30 m, but they did ask us to map seasonal water [inaudible 0:17:40] Africa because they were interested in how that affected rangeland management, because if you've got surface water you're going to have your forage for your animals and you can water the animals. So that was the interest there. |
| | There are very, very specific questions like the agriculture one where we are going to pay a farmer a subsidy for maintaining their land in good environmental condition and there are very specific identifiers for what that means. You must keep soil conservation terraces in place, you must not burn stubble, you must not plough it in, you must leave it on the surface of the ground and then you can look at the satellite imagery and see was that complied with or not? So in that case it's a mixture of both I think. |
| SO: | Is that something that is just interesting information or would action follow? |
| AB: | No, that action actually follows in that case, yes, it's actually a legal constraint then that the farmer would be deemed to be not compliant with the rules of that particular regulation. |
| IH: | How do you categorise sort of different land usage, types of land use? So even when your resolution changes the scheme of categorisation presumably changes as well, so how do you deal with that? |
| AB: | Well when we're working at 1 km resolution we are very much bound by the drivers for the climate modelling community, so we'll go for fairly broad land cover categories. When you come down to finer and finer resolution then you can start to make implications about land use but you're not really observing land use, you're implying it. So we always go from cover effectively, that's what we are observing. But the legend of the map you produce is scale dependent, yes. |
| MR2: | Sorry, has that changed...? I mean if you can measure the good environmental condition [inaudible 0:19:39] presumably you can do all sorts of things potentially... |
| AB: | Yes. |
| MR2: | ...about land use presumably, about what the land is being used for. I guess I'm thinking about sort of multiple product or multiple outputs from land, that if we are interested in biodiversity or we're interested in food grow...all these things, then rather than just saying this is agricultural or even this is wheat presumably we can begin to say this has got some interesting hedges and this is got some wetlands and so on. So you're into...I guess you need categories to be able to say this is what it's like in the UK compared with this or what it's like in Europe, wherever, to be able to sort of assemble the information in some way that other people can understand. |
| AB: | That's correct. I mean the one thing that you've got in your favour using the satellite is that yes, if you want to compare Italy with the UK you can, but then you could also compare those with Bolivia or Zimbabwe or anywhere because you've got exactly the same measurement protocol everywhere and it's got finer. Even one year ago realistically to talk about global scale product at 30 m was a long shot, it was 1 km or the best was about 300 m, we were able to cope with those data flow. But it's literally in the last year or so had this quantum leap and we're really trying to work out where we're going with it. |
| MR2: | Yeah, that's right, really catching up to do to try and sort of work out what to do with it. |
| AB: | Yeah, and you can do a lot of new stuff with it. |
| KM: | I wondered if there's...I mean this is really interesting, and at that level of... |
| AB: | We're all good listeners aren't we? |



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| KM: | At that level of resolution is there any kind of opportunities to a) understand what is driving levels of change and b) looking at any predictions or scenarios? If you're able to look at a time period, you know, you said you've got data from 42 years, you've seen sort of nibbling effects accelerating and you can think 'actually that's being driven by this and this.' |
| AB: | Yes. Yes and no. I work for the European Commission [overspeaking 0:21:57]. You can observe the change, attributing a cause to that change is always the tricky bit and that's where what you've put round the table here in the forum is so powerful because you are bringing all the different groups together. It's why we like working with Jon so much because they are looking at drivers of change. We pick up all sorts of fascinating patterns, we see patterns of biomass burning changing for example. When it's a rangeland ecosystem you've got huge fires, I mean they can be hundreds of kilometres in size some of them. Then you find the farmers move in, start converting the land from rangeland to farmland and the farmer doesn't use fire in the same way as the rangeland manager does and you get a different spatial pattern of fire. Now we see the change in the fire pattern, we then have to work out what might cause that and then you have to go and check it, but there are things like that that are very real that you see. |
| MP: | [inaudible 0:23:04] being able to do things like real-time determination of crop yields and [inaudible 0:23:10] of crop diseases for example [inaudible 0:23:15]. |
| AB: | Yeah. We are moving rapidly in that direction. Again Google have just bought something from Skybox and they are a series of small satellites called skysats. They're actually a bit bigger than the ones you were...we were talking earlier, there's a new relative of the Bavarian Pigeon Corps and they're called Doves and there is a company called Planet Lab who literally through 24 of them out the window of the International Space Station in February. |
| MR1: | Shoebox size. |
| AB: | Yeah, they are, they're 3... |
| MR1: | 10 x 30. |
| AB: | 10 x 30, they are three cube size put together. But the things that Google have bought are much bigger than that, they're sort of that sort of size and they are hooked into the notion that they're sort of hardwired into processing on site. So the data will come in, will be converted into a crop yield or a crop health measurement, because you're using visible and near infrared changes in reflectance which can be related back to crop condition. But it's done in near real-time, you would never see the data you'd just see the product at the end of it, it is literally a blackbox approach that they're adopting. |
| MP: | And that's what, now or [inaudible 0:24:31]? |
| AB: | Now-ish. They've got two satellite [inaudible 0:24:33], you can find the data on the web, you can see example images from these things. |
| MR1: | How often do they revisit a particular point? |
| AB: | Well again the intention is to put a whole constellation like Planet [inaudible 0:24:47], so it's every day. So they're shooting for sub metre daily revisits, we're not at sub metre daily revisits yet but it's very, very close. There will be all sorts of questions of quality because in the climate world which I've been mainly involved in, trying to build up long time series for climate measurements, you've got to be absolutely precise with the calibration of the instruments, you have to take up every single variation in sensor performance. We spend years cross calibrating three or four Landsats. Here you're going to put 24 satellites up, you've got 24 different launch conditions and you're going to be able to make fractional measurements between them. It's not going to be the same level of precision. So I think we have to put a lot of health warnings on this stuff. |



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| MP: | Following on from that what do you see as the biggest risks for this? It's an incredible opportunity but I can see it all going horribly wrong. |
| AB: | Yeah. I see one risk is that...is...I mean the pictures are very powerful and you can see a huge amount and there is a wonderful tendency to oversell it. I think it will do stuff and I think that for crop yield and for crop health and things like that it might work, but when you're looking at very, very careful measurements I think the calibration of instruments is...we can't get away from the fact that for climate measurements and things like that we're talking very, very small change and the precision is going to be very important. |
| MP: | Presumably you could come to similar conclusions, I was thinking about some of the biodiversity data, you could come to conclusions and policy recommendations that could theoretically be very powerful. |
| AB: | Very much so, very much so, yeah. |
| MP: | But could also lead in the wrong direction. |
| AB: | Possibly, yeah. I mean Jon's probably more [overspeaking 0:26:59]. |
| JH: | I've been in the wrong direction many times, so nothing new there. |
| MR1: | I think we'll move on. Would it make sense to have Lucas next as slightly closer? |
| LJ: | Sure. |
| JH: | Well mine is along the same sort of lines so I don't know whether... |
| LJ: | Mine is going to be as well. |
| JH: | But you should never start a presentation with an apology but I'm going to - so I've just come back this weekend from Australia and this is about the time of day when I start looking for somewhere horizontal. It's a very attractive room in that regard. So I've taken the liberty of writing something down and therefore having written it down I'm going to read it, so I hope you don't mind too much. |
| | So when Roz got hold of me she said this was about land use change, datasets and research questions and she asked specifically what do you perceive as being the main gaps in our knowledge and what would you include in the next generation of research questions? I mean what else would you expect from a place like Cambridge? That's the sort of thing you'd expect people to be asking. But I mean my first response was that kind of depends on what the question is that you're trying to answer. There are a lot of things that we want to get from remote sensing or in this case from satellite sensing. Someone's already mentioned predictions of agricultural outputs or yield, that's a possibility, growth of agriculture and the associated loss of natural ecosystems would be of interest to us and much more specifically we are very interested in what contribution remote sensing can make to measuring progress towards these Aichi targets which many of you will be familiar with, they are the 2020 global targets for biodiversity. |
| | So I'm sort of thinking the question for me will be different to the question from a lot of other people sitting at the table. So to be very clear I'm speaking through the lens, the prism of someone dealing with biodiversity and we are interested in land use change which in some way equates to habitat loss in the language of the biodiversity scientists, which equates as we know very strongly to the primary reason for deterioration of species' status and I suspect that Lucas will be saying much more about that so I won't. And then I'd add that this is something that we're actually working on with the Convention on Biological Diversity and in fact Alan and I were at an event in Korea not long ago talking about exactly the same sort of thing. |
| | On that occasion it took me a long time to get to the conclusion by which time everyone was asleep so I won't inflict that on you. So I'll start with my conclusion which is that after 30 years of promise and indeed promises, you know back further to 1983 just after...in |



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| | <p>fact there was stuff going on in the 70s when I was here at Cambridge, we still can't quickly and simply measure land use change other than in a very limited context. Now we know that that's [inaudible 0:30:22], we've just heard that, so in the future we'll be in a better position, but it's actually quite difficult to look back and see where are we now relative to history and how are these things changing over time.</p> |
| | <p>So from the biodiversity perspective at least anyway we need a multi-decadal, global and [inaudible 0:30:45] biodiversity relevant fully comparable land cover change product so that we can track change and this progress towards the Aichi targets. Then I've added - and I'm not entirely sure about this and I'm having some disagreements with folks - that I actually think that the classes... someone mentioned earlier the classifications, I think we need a product which is designed specifically to answer some biodiversity questions, so I'm not sure the generalised classification that we've got now is really going to do it for us, so I think we need something special.</p> |
| | <p>The reality is that in the absence of these products what we get is very bad science, so I'm going to actually quote a product from... this is not the bad science, this is good science, but from Alan and the JRC and the European Space Agency which is GlobCover which was as many of you will know there's a 2005 and 2009 version [inaudible 0:31:47]. But the point is they're both good products, 2005 and 2009, and you would think if you just subtract one from the other you would get some measure of land use change, but in fact that would be simple, intuitive and wrong. In fact the JRC or ESA or both actually have a disclaimer that says 'GlobCover 2009 cannot be used for any change detection application, in particular the direct comparison with previous GlobCover 2005 should be avoided, blah, blah, blah.' So it's clearly there in the text of the product but in fact I know of several commercial products, companies who are making very significant money who do precisely this and these tools are [inaudible 0:32:33], mostly consulting companies. And so actually there are a lot of major companies in the agricultural sector I think who are using this kind of data and this kind of analysis and clearly they are being misled, they're just very bad science.</p> |
| | <p>Now it's not as if we aren't aware that this is a problem, I mean it's not as if there's been no intent to address it, so there was a global land cover data initiative which NASA was very enthusiastic about in 2010. It was launched by the Deputy Secretary of the Interior at the GO Summit and it was going to take 30 m resolution and was going to do all the things we'd like to do - you know have the time series so that we can see what's been going on since perhaps back in the 80s. We're still waiting, nothing actually has been produced I don't think it's going to be produced. Have you seen sign of movement? No.</p> |
| | <p>So in that regard we are lacking. Now when you ask people why it is that we are lacking the usual explanation lies around technology and technology is an issue and we've heard how it's being overcome in many ways. So I've got a list of things that people talk about: sort of limited Internet access, bandwidth, limited access to satellite imagery due to restricted data policies. All of those are absolutely true and many of them are being overcome but actually I think... well this is the truth but at best it's only part of the truth because a lot of the reasons we don't have this product are the human reasons which a lot of people around the table... everybody actually around the table will recognise. It is because first of all Earth observation is cool, it's great to be doing this stuff, actually there isn't a Lidar or anything at the moment, but if you had a Lidar it would be even cooler. Tracking wild animal movement from satellite tags, trying to estimate carbon, you know, all the... and NDVI, all those really cool things people are using them and they are fantastic and they do give results and answer questions. But everybody wants the highest resolution, everyone wants to work at 25 cm and it's getting cheaper so probably everyone's going to be able to. PhD students, they have to have novel, new ideas, right? And their work needs to be not some repetition of what someone did in 1984 - it happens occasionally - but it needs to be new and funding is competitive in short cycles. I mean these people trying to do these products have got three year funding. I know two products at NASA at the jet propulsion lab there where they started something really interesting but</p> |

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| | the money ran out and after three years the whole thing came tumbling down, they never produced a long-term product because the system is set up just like it is for all academic, if you like, and research projects on short timescales. |
| | Then finally there aren't many career rewards for working on old data at low resolutions. When you think about it there are very good reasons why no one has done this. |
| | So the bottom line is this remote sensing is great and it's going to be fantastic for the future but it hasn't been conducive to long-term monitoring and part of it is technical, but part of it if you like is the human end and the institutional end of the equation. New products are rarely compatible with old products and for the most part we simply can't measure change and certainly we can't look backwards and make any sense of it. |
| | The next thing I have to do though is make a caveat before someone points it out, so there is in fact a 10 year land cover product which has recently been produced by the National Geomatics Center of China at 30 m for 11 thematic classes. Alan and I have both looked at it and discussed it and we're ground truthing it. There are major challenges with the compatibility of the classification system and it will have some usage but I think it's going to be tricky. But they did it by putting an army, I think it was as many as 800 postgrads and students onto this thing so they mobilised the human resources, which in fact you'd probably need to process this old imagery. |
| | So my conclusions then are remote sensing as far as the biodiversity community is concerned hasn't yet delivered. It's delivered some really cool stuff, I mean I'd be the last person to criticise people who get excited about remote sensing of turtles and albatrosses and things, this is really important data, but that solid benchmark that we need about how the world is changing we don't have. Data and computing access are important but actually it's about incentives and interests and the misalignment in institutions of those things, changing priorities and funding. |
| | But also I have to put my hand up and say there is another major problem which is that our community, the biodiversity community, we have not got our heads together and had a consistent story to tell. We have not gone to the European Space Agency or NASA or anyone and said 'Okay, this is all very cool but we want this one product as a priority and we want it in the next five years.' We simply have not done that because what happens is we tend to get together with the space agencies and everyone's kind of angling saying 'Look I've heard you've got this new...could you actually do this analysis for us?' So we've been our own worst enemies. I do have some...that was my conclusion, I do have some post-conclusion remarks but I think I'll save them [inaudible 0:38:29]. |
| MR1: | Thank you very much. Any questions? |
| SO: | [inaudible 0:38:37]. I mean we're getting better and better at looking at what goes on on the land but have you got much concept of what we've seen from [overspeaking 0:38:51]. |
| JH: | I'm sure Alan can say much more than me but I can give you some experience that we've had. So NASA and University of Florida in 2000 tried to put together what they called the Millennium Reef Assessment where they used various sensors and I think it went down to 40 m. So they were able to...they looked at about 40 attributes for different coral [inaudible 0:39:16] and so on and tried to classify them. They collected so much data that the researcher never finished and actually what happened was we ended up with all the data from the University of Florida and all we've managed to do is look at the polygon, we've mapped where the coral is. So all that data at the moment has gone to waste. So there is real potential but it suffers from the same essential issues, but I'm sure Alan has got far more to say about this. |
| AB: | Just very quickly [inaudible 0:39:43] global version of the system which advocates and actually looks at data comparison between three main categories: there's sea surface temperature and there's a lot of inter-comparison work on that and ocean cover and [inaudible 0:40:00] and there are decent satellite datasets of all three of those where there |



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| | is a pretty rigorous inter-comparison exercise to narrow down the error between the different algorithms and the different sensors, the different orbits they're in and so on. So I'd say on a number of metrics, yes, we're doing pretty well. |
| MP: | Is that data being tied to [inaudible 0:40:24] or the older oceanographic datasets? [inaudible 0:40:36]. |
| AB: | No, I can't answer that. I wouldn't like to answer it because I'd probably say something wrong. |
| PL: | [inaudible 0:40:52] good correlations with those. I think kind of similar to what Alan is saying about seeing things on different scales [inaudible 0:41:00] have just revolutionised our view about how the ocean behaves [inaudible 0:41:05] around gently to a sea full of weather fronts and [inaudible 0:41:13] it's completely changed the view of [inaudible 0:41:16]. But I imagine that when one looks at the land that I'd be amazed if one doesn't see similar things [inaudible 0:41:24]. |
| JH: | There are thermal measurements of land, there are land surface temperature movements. |
| IH: | I'll just sort of lob in my usual grenade, but it's a question more for Mike as well as Jon really, but I mean here you are...and also for Microsoft, here we are, you're allied with the University, we've got a conservation initiative, we've got Microsoft down the road, so why is there such a problem in developing this product that you see as being so central? Surely this is the ideal opportunity for PhD students, for programmers to be directed towards generating what you need? |
| JH: | Well I think it's not very interesting for PhD students is a large part of the problem. It's repetitive, low resolution, preparation mostly of images I think and I don't think it is...it's really an unattractive grunt piece of work that needs doing. Now maybe that's a good reason to go to Microsoft actually. In fairness we have worked...we've had a three year collaboration with Microsoft which Lucas has been part of, in and out of, working on building new models for biodiversity which is the kind of thing I think Microsoft is interested in that is the innovation, it's all the things you would expect. I can't imagine Microsoft wanting to get involved with processing all this imagery. |
| MR1: | Would you like it to? |
| LJ: | Yeah. Yeah, we can talk about this as part of my statement as well. You know I think Jon's right and one of the things that I will get to and that Jon ended on is an issue of incentives and I think when you're looking at private corporations we need a monetary incentive to do this for some reason or another. It doesn't need to be monetary but it has to be some sort of incentive, right? It can even be a consumer driven incentive that you see this corporation as large enough to have a more obligation to do certain things, but that still needs to be communicated from a market and that can be a vocal minority of the conservation community clamouring and saying 'The world's technology corporations owe it to the world to deliver it.' But you can't just say [inaudible 0:44:00] or Eric Schmidt or Sergey Brin, they're not going to just wake up and be like 'Hey, you know what we should do? Like not deliver money back to our shareholders because [inaudible 0:44:08].' |
| WS: | I was wondering what your impression is of the global forest cover maps produced by Hansen and colleagues at Maryland University which you can view through the Global Forest Watch, whether you think that's the kind of product that is actually useful or can tell us something about biodiversity? |
| JH: | What do I think about it? I think it's very good. I mean Hansen's work is very good and it's one of the examples where there is a product, I mean the forest work side with the tropics actually started just with Latin America but it's built out and I think there's going to be a forest product, or perhaps there is already. So that's the one, if you like, biome where we can begin to look at change. Do I think it's useful? Actually I don't at the moment. I mean you go there and instead of developing it as a product which would give you linear change |



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| | and indicators associated with that they just decided to go the route that everyone does which is shoving more data on it and now they've got concessions for extractive industries and where the great apes build their nests. What on earth are you going to do with all that? What question are you going to ask it and how is it going to answer it? It's just more, more, more data. So I'm not telling you anything here I haven't told them, because they came to us and said 'We want all your data.' Well, you know, kind of what for? Just do the basic job well. So what we've done is we've offered to work with them - and I've got someone over there now - on trying to figure out how they can answer five really simple questions around the Aichi targets about forest change. |
| AS: | What sort of questions? |
| JH: | Gosh! How much has forest changed? I was being facetious. I don't know because I don't know what the formulation was, but they are tailored to the Aichi targets and if they can even answer a couple of those I think...and then they can do what they like with the rest of the data but we've got to get something out of all that money being spent on it. |
| TR: | I have a question. I was really interested that you said...you talked about using data that is in the context of biodiversity measurements and obviously I guess for land use perhaps the satellite data translates better into other [inaudible 0:46:31] land use. Do you think...and in terms of thinking in gaps of knowledge do you think we need also more data from the ground [inaudible 0:46:41] to the satellite imagery in order to give us more of a feel for the biodiversity? |
| JH: | Well the simple answer to that is yes and in fact that's why this group, the GO Biodiversity Observation Network are trying to put together what they call essential biodiversity variables, the stuff that we should have been collecting 40, 50 years ago so we've built up a [inaudible 0:47:05] of...a set of data that we could draw conclusions from. Actually it's great they're doing it but it's too late, I mean the change is happening now and we have to use the best information we can. What you find more and more of, rather circular, is that people look at an ecosystem and they work out what kind of species or critters there would be in there and because they can't see those critters from space they look at how big the ecosystem is and how it's shrinking and they make some calculations as to what percentage of the critters are left. But we have no idea whether that's accurate or not, I mean intuitively it's probably much better than nothing but... |
| MR1: | I think we ought to go on and hear Lucas and then have general discussion. |
| LJ: | I'll probably keep it a bit shorter because the conversation is kind of starting already and I'm happy being part of it, I'm happy to answer questions about Microsoft, about the technology space from my own personal opinion. |
| | The message that I have is pretty simple. I'm a simple guy, I have aspirations to be more than that but it's just not working out. You know I've always wanted...so ecology, I always wanted to be a theoretical ecologist, I wanted to prove that I could do fancy things and make fancy predictions and instead of doing that I kept getting waylaid by these basic questions, just going back to the basics, the most simple stuff of saying 'Yeah, but what am I making predictions about when I don't even have data to make predictions on? How do I even know that my predictions are right? I don't know what things looked like in the past, I just don't know.' That kind of is the overall message of what I'd like to deliver here is basically what I fundamentally think we need is more data but I am sympathetic to where Jon is coming from on that. I think that we...it astounds me, it continues to astound me that we have satellites being launched where 31 cm resolution, potential for 25 and I still can't find out who owns what land, what... I mean I could maybe if I spent a long, long, long, long time. I can find out where every Starbucks is but I can't find out who they got that lease from, how long that lease is for, who owns the land and without knowing that information, whether it's about Starbucks - which is maybe what my company might care more about at the moment - or land grabs in Africa or deforestation in Brazil. It's very, very, very difficult to figure out the human motives behind what's going to happen to |



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| | that land, whether that's for concessions, industrial extraction, high agriculture or what have you. |
| | We need to meet those data in the middle with an understanding of what's on it and inference about what could most profitably be on it. And I don't mean profit in a [inaudible 0:50:38], I mean profit in an operable sort of a way. What are the soil types? What's the climate? What could be done with that land? Who owns it? And those two things generally [inaudible 0:50:53] economies merge to create our future, right? Of how cities expand and how rural areas collapse and how deforestation [inaudible 0:51:04] continue. |
| | And so there's then some significant [inaudible 0:51:10] in this. I mean one of the darlings of the investor world at the moment in the US is something called Zillo.com, I mean these things are popping up everywhere, right? It's kind of this perfect marriage of machine learning, open public data and something that everybody cares about which are houses and how much that house is going to cost, who owns that house, what it sold for in the past, what it's projected sales price is into the future and it will also show you the allotment and spatial delineation of that. But unlike satellite imagery which has become fairly ubiquitous - you go on Google Maps, Google Earth, [inaudible 0:51:53] maps, WorldWide Telescope, what have you, and you can peer down from space at various resolutions and you can see some stuff. But in companies like ours we care less about big data and more about the information in those data, right? And so what Alan's been talking a lot about is how do you extract information from these raw data streams and what Skybox for instance from Google is all about...or Google's acquisition of Skybox which only cost them \$500 million which is amazing and they're not even...they're trying to do device side extraction of data into information and streaming that back. They're doing that for an economic reason because...and we can talk about this in other projects as well, but the data started to pile up, there's very little information and/or surprise in much of these data. So a few terabytes better streaming download every day, most of us don't really care, there's nothing going on, right? And so this is why mathematicians think of sparse matrices and things like that because why would you constantly [inaudible 0:53:10] row by column matrix when there's only four data points in it? |
| | So anyway, I think that we need to marry up information and this completely blows my mind that the company I work for, our primary competitor, Microsoft do good work in the information market, we're defining the information economy and neither of us is working on the most valuable information in the world which is who owns what land and why? Instead we're trying to figure out what size trousers you wear so that we can figure out what ads to put on your e-mail. |
| | So that's crazy. I think that probably will change and things are slowly moving that way, I mean the Skybox acquisition is a good one but there they talk about it...you'll find that Google talks a lot about the environment when they have other motives and so the main rationale behind Skybox at the moment is not particularly about environmental information, it's just that this is another dimension of information. And they have all sorts of information and they're the masters of the blackbox. So you know they can do a fairly good job of things like correlating the number of people going in and out of the NASDAQ building and the number of crates at the Port of Seattle dock and this and that to make predictions about you name it, right? I mean correlations exist, correlation is not causation but if you're making very short temporal predictions it turns out that that is not so important. |
| | So they're getting quite good at that but as a result we're starting to gain some important tools and indeed Microsoft has some things going on in that place as well. |
| | So anyway, who owns it and what's on it, those two things are fundamentally important. We should be able to draw on a map, get information back about that place. Right now you can find out if there's a Starbucks there and how long it will take you to walk, but you cannot find out anything more than that. I think that needs to change if we want to be able to answer these larger scale questions, whether it's energy, agriculture, biodiversity or the |

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| | nexus problem. |
| | I'm going to end on this but I would just reiterate Jon's point about consistency and Jon's been to a lot of meetings with me with various organisations and he's completely right, everybody says 'Oh the next best thing, the next best thing. We need higher resolution. We need this, we need that, we need to not be wrong.' I keep saying it doesn't matter if you're wrong as long as you're consistently wrong, right? Because then when we figure it out we can fix the whole shebang. The problem with the remote sensing community is they keep finding out that they are wrong, but we're human, we are always wrong, but they keep fixing it along the way and that means that we can't then go back and backfill anything and you're like I'm so happy that you fixed your mistake but actually the fixing of the mistake was the larger mistake. |
| | So we do need consistency in measuring and monitoring. I mean the long-term [inaudible 0:56:32] recorders has to be a good example of this, it's low-tech but it's been going forever. In climate change studies the ice on/ice off is...and these things back from Emperors crossing lakes to go meet in the middle once a year on a particular day in January, those things have been recorded for thousands of years and we're mining those data more effectively than we are 31 cm resolution land cover at the moment. I believe we will do so with that into the future. |
| | I will kind of end on that. We can talk...you can ask me questions about agriculture, there's lots going on in that space with...and anything else. |
| MR1: | On the land use question, I mean this country has the Land Registry which is publicly available I think and so I suppose the problem is whether all countries have a similar thing, so presumably that's the problem, especially Africa. |
| LJ: | And so what's amazing...I've been a long-time admirer WCMC and in particular one of their products - the World Database of Protected Areas and a lot of my work was always in trying to assess the impact of protected areas. It turns out that some of the most difficult information is trying to figure out where protected areas are in the first place. Jon's had an amazing team working for years and years and years to do this and these are things that people create, right? That information is somewhere but compiling it is a non-trivial task as Jon will attest to, and what that means is that for all of this stuff we end up trying to find proxies to trace the blueprint of human actions, when in fact we had a blueprint in the first place. So if we could just get that information back together it would be hugely helpful. And the Land Registry...so Zillo, they're polling those data and it's been recently with open government data that that has significantly changed. But you will find that it's still very, very difficult to...because it will be my district or council or whatever, there is not a place in the UK that you just go and click on a map and it says 'hey that', you know what I mean? So I've just bought a house scarily enough and trying to figure out the appropriate authority, and they all have their own weird mapping systems that don't work because they're...you know...and it's just amazing. And then, even then in 2014 in one of the fastest growing regions of the United States in one of the tech hubs, my backyard, the King County says 'We don't know who owns that', and Sammamish City Council says 'We don't know either', it's just unknown. And I'm like...literally one of the fastest expanding parts of...the richest parts of the United States, just my backyard, people have no idea. |
| MR2: | Just take it. |
| LJ: | Yeah, so now we're all cutting the trees down, I'm 'Right, okay, I'm gonna get that.' And so that really...you know we're trying to do sub centimetre, sub metre mapping of this place and that place you still can't even tell me who owns my backyard? Like well that, if you want to know the driver - I mean this is a tangential [inaudible 1:00:03] - but if you want to know the driver of why that's being cleared, it's actually the driver is the lack of ownership, right? |

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| | Anyway, that's a basic point. |
| MP: | But in fact you won't find in the UK, you won't find out from the Land Registry who owns all the land because a lot of it's not in there, because it's only registered when the land is sold and quite a lot of land has not been sold over the last 15 years [inaudible 1:00:33] since they've been doing it. The reason for that is that a lot of large landowners do not want people to know how much they own and actually they get quite uppity when people start trying to work it out. So there is an issue of confidentiality that I guess sort of working against this ever more and more data about some of the human side from what's going on on the ground. |
| LJ: | So that's completely true, I think I would go back to the...that's completely true and it was true about Google Street View, you know, like driving around and a lot of people didn't want pictures of their houses posted. A lot of people didn't want, even though it was always true, it was hidden and difficult to access information about for instance the sales price of your house, a lot of people don't want you to know how much I paid for my house, right? Well the commis in the US always published that but unless you lived there you had to go and look for it. Well now everybody can find out everything about anything in that regard and so I find it kind of awkward that all my friends are like 'Oh hey!' you know like, 'I saw...we were just looking at pictures of your house online', and I'm like 'Oh that's cool that you saw pictures of my house kind of', but then I'm going 'Oh well you saw how much I paid for it, you know how much my mortgage is', you know all that kind of information. |
| | But don't get me wrong, I'm as leery as everybody here but that's where everything is going and it's for us to figure out how to manage it and voice our concerns about... |
| MP: | But it goes back to your point about who is going to do this, because Microsoft is only going to do it if there's some money in it for them. |
| LJ: | Yeah. |
| MP: | So what...in a sense that's quite scary I think because you're sort of saying we're getting used to it and that's okay but we're also saying actually it's not a process that is being driven by people who just want to make money out of it because they need to provide income to their shareholders. |
| LJ: | It doesn't have to be that way though. I think what's interesting is your Commission is looking to a private corporation to process imagery that is in the public good, right? |
| AB: | No, we're using them just out of necessity. |
| LJ: | But that's what I'm saying is that you are looking at them for the technological solutions to do that and then on the other hand you say, 'Well, why do we rely on private corporations [inaudible 1:03:09] we shouldn't have to.' I don't think...my private personal opinion is that they shouldn't have to do that. |
| AB: | Well we're trying very hard not to as well. I would be delighted not to and I really genuinely believe that Europe...we put €3 plus billion into building these Sentinels and we've not invested anything in the ground say, and I think it's a really shortsighted step forward. We're going to have all these glorious data flowing down and we're not going to be able to use them properly. And at the moment me using Google Earth Engine is actually a statement of intent to my colleagues saying 'Look, I have to do this because there is no alternative in Europe', and that is a really back step, it's a step backwards, it's an enormous step backwards. |
| | We have launched...Sentinel-2 again in my view will be a state-of-the-art machine, it's going to measure at 10 m resolution which is perfectly acceptable for all the global stuff we do but it's a properly calibrated, well understood...it's a Rolls-Royce instrument, it's not a...it's something that we really can understand the measurements from it, but we're not |

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| | going to be able to use it to its maximum. |
| MP: | Just the implication, perhaps Google should pay its taxes. |
| AB: | [inaudible 1:04:35]. |
| MP: | [inaudible 1:04:41]. |
| SO: | I just wanted to try and pick up on the [inaudible 1:04:43]. We've talked a lot about data which we seem to have coming out of our ears and far too much to do anything sensible with and yet we still want more so it's kind of an addiction. [inaudible 1:05:02]. So data, so what you refer to is information and some of that is [inaudible 1:05:13] that can't be delivered [inaudible 1:05:24]. So then there's the stuff we can do with that which is obviously more interesting than Miles might think and then there's what, I guess, most of the people around the table would be interested in which is change in outcomes. And if you try to work back from change in outcomes, though Miles might correct me, but I think it's probably quite a widely shared view that [inaudible 1:05:55] biodiversity [inaudible 1:05:58] country boundaries to be [inaudible 1:06:05]. But you could say that actually it's quite, in some cases, not all, that really landowners as a community is interested in its own good, have a pretty shrewd idea of why it's happening. We don't need more data, we might need a bit more information, but what's really happening is that and not [inaudible 1:06:31]. That's a kind of extreme [inaudible 1:06:36]. So I suppose what I was feeling for was is to what extent is lack of data [inaudible 1:06:44] as opposed to lack of other data? |
| MR1: | Miles and then you've got the power of the EU behind you so you come first. |
| MP: | [inaudible 1:06:59]. It seems to me it actually can be a major impediment that has much more power [inaudible 1:07:07]. To give you a very crude example from the [inaudible 1:07:11] came to the table discuss quotas and so forth [inaudible 1:07:22] Hughes turned up to the table [inaudible 1:07:26] and I said 'Why are you here? You don't fish in Icelandic waters', 'Oh yes we can', they said. [inaudible 1:07:34]. |
| SO: | [inaudible 1:07:43]. |
| IH: | But it needs very, very specific... So whether Portugal is fishing in a particular place or... I was struck with your enforcement of crude environmental condition rules [inaudible 1:08:08] policy, very specific rather than... and I guess it's small needles I guess. |
| AB: | I mean there's the whole public advocacy thing going on in the Amazon Forest at the moment which is linked to the tenure issue as well. It's the fact that you have indigenous people who believe we own this area of forest. Then some mining company or an oil exploration company or an illegal logger comes in and starts clearing it and these guys are actually now sufficiently well integrated into the system to go ahead, download the satellite imagery and then go back to local government and say 'Oy! Somebody's clearing my land', and they have the evidence as you said to say 'Get out!' or to turn to government and say 'You are not respecting the boundaries that you agreed on'. |
| JH: | Something we talked about earlier is also the kind of data you can legally present and so the very visual nature of some of the data that you're able to do, that particularly empowers them much more. [inaudible 1:09:16] very numerical kind of data. |
| AB: | Yes that's right, they don't need to understand the physics of it, they just have a picture to show it. |
| SO: | [inaudible 1:09:23]. |
| AS: | Can I ask? I'm not a fan of these crazy theories at all but I just wonder, just going back to the discussion about who owns the land and whether people want us to find out whether you own it or not, to what extent is this data pure? I'm not talking about ground [inaudible 1:09:51] I'm talking about to what extent has it been interfered with? Governments saying 'Oh we don't want these particular installations in our area looked at.' How do you worry? |



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| | Do you worry about terabytes and terabytes of data being hacked? |
| AB: | Yes. I remember looking at aerial photography of the Cardington area, North Bedford, and the...what is it called the [inaudible 1:10:23] case, the US listening post would wipe it out, so there would be a white blob on the aerial photography and then you looked at the Landsat mapper image and you can see it. The nuclear research centre that I work in on the original Google Earth was forest, somebody had Photoshopped a forest onto it, but now you see everything. Somebody was actually wasting their time. There's so much data out there and there are 19 million satellites flying, somebody is going to get it out there, so... |
| AS: | And you don't think there's any possibility of technology that could interfere with this? I'm just throwing out these slightly ridiculous ideas but what you've said, [inaudible 1:11:01]. |
| LJ: | I mean any time you have information...any time you have data moving and people are somehow going to extract information from it, usually with satellite imagery where we view that as visually and mentally, right? We look at something and we extract information and we call it a forest or we call it a nuclear facility or something like that. You can mess with it right? We try to regulate that. I mean Google could mess with search results, Microsoft could mess with search results, in fact they do, I mean that's their business is messing with information and bringing it back in a way that they think...but they can mess with it maliciously in that they drop you from...they can drop you in your search rankings and stuff like that. It's a massive industry, black hat versus white hat kind of search optimisation methods, so if you are a small corporation and you want to rise up in Google's ranks or Microsoft's ranks you hire somebody for a lot of money to come in and tweak your website to get it to pop back up and then Google goes [inaudible 1:12:14] pop back down. And the same thing [inaudible 1:12:18] or whatever, you know there's Bing, there's Google and there's many, many other search engines if you want. The federal government of the US or the government here or whatever could mess with whatever the EU satellites to show that but, you know, Skybox just popped up a satellite and it's going to show up there or it's going to show up somewhere, so I mean...people are always messing with it. |
| IH: | I think there's a bigger issue where actually interpreting the satellite data depends entirely on the ground information and this comes back to the point we were making that with agricultural land that we anonymise agricultural data in this country. Agricultural statistics are carefully managed so that you can't identify the individual parts and I know that's quite intentional. But if you do that then it doesn't matter how good the satellite data is you're not going to be able to [inaudible 1:13:19] what we know about crops and property on [inaudible 1:13:24] satellite data. |
| LJ: | Although we still can kind of turn to that. |
| IH: | Well eventually. |
| MR1: | I think we should probably have our tea break now and we were going to break into three groups, I think we should perhaps discuss it over tea whether we want to do that because my impression is there's more sort of commonality between the three speakers than at most meetings, so it may be that it's best for us to just get round the table again, but we can discuss that during coffee break. So let's have a 10 minute break now. |
| | [After break 1:15:10] Could I kick off by saying that in the context of land ownership from the sort of scary long-term thing between the purchase of [inaudible 1:15:17] of Africa by China and Arab countries, you know this is said to be clearly very important for the [inaudible 1:15:21] Africa Rising. Is this something that you're monitoring especially or is this something where other organisations will be fed in? |
| AB: | We are...the Commission is looking at it [inaudible 1:15:41] issue. We believe that perhaps not quite as much has been sold as was deemed to have been sold but a lot has been sold. It comes back to the point that you were making earlier that we can see |

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| | changes in the land cover but you can't actually identify the ownership. One of the problems that we know in Africa is that the same plot of land will be sold more than once and then you own it and you own it and then if you'd like to settle it go to court and we'll just stand back and watch. And I know from talking to colleagues in South America that happens but this man is a true expert in some of that stuff. |
| JH: | Well only in so much as I come from Zimbabwe. |
| AB: | How many times have you sold land? |
| MR1: | Is this an issue Jon? |
| JH: | It was an issue. I mean it's quite clear that there were some pricing laws and people started to get concerned about food security, however you define that, then people started to look at where they could find land. It has died away but I mean what we're looking at...it was quite clear the scramble for land was an awful lot quicker than the monitoring could ever be, so you were always going to be behind the curve and things were happening and you were always trying to catch up. What we've decided to do now is rather change the way we look at it, so we're doing as Lucas said looking at agricultural potential, looking at the mineral potential, all sorts of other potentials which you can of course measure in different ways and there's a lot of issues there. And then essentially saying whether it's five years or whether it's 50 years or 500 years this land will be used and we have to assume with all the forces at the moment. So where are the really important areas for biodiversity? That's a challenge because different people think biodiversity is something different from important biodiversity - no one can agree on what's important. But I mean if we can classify things we can start to look at where the real flashpoints are going to be and we're trying to become more proactive. Because the history of conservation actually is people fighting each little battle one by one and we just get steamrollered actually by these big processes, so we need to have a different approach. So we're currently working actually with WWF and the African Development Bank on looking at these large-scale processes and trying to be more predictive. And also actually...and trying to get people to understand that you won't save everything, you know we have to accept the inevitable, there will be big large-scale changes in Africa, it will look more like Europe in some timeframe which we don't know yet and we'd better get used to it. |
| LJ: | One of the things I would say is that the [inaudible 1:18:52], you know, it's going to be...in many countries it already is but it will just increasingly be raised as an issue of national security, national interest in...and a lot of [inaudible 1:19:07] because the countries themselves don't know what's going on within their border. But you know, I mean, we don't have...we're not talking about it so much in the UK of land grabs for agriculture by China or something, but it's in the newspapers pretty much every day about land grabs going on in London with [inaudible 1:19:28] urban properties. I think it's the exact same market dynamic and you see it started happening and then the public started noticing and then [inaudible 1:19:38] now the conversation is should the government step in and that's how this happened. |
| MR1: | They seem highly relaxed about it. |
| LJ: | And they do seem highly relaxed. I've seen...it's like a lot of countries when it comes to agricultural land grabs and things are seeming fairly relaxed about it anyway and that's up to the citizens of those countries to decide whether or not they should be relaxed about it. So it is happening. This foreign investment in land is happening no place more than 60 miles from here, anywhere in the world, and there's a lot to be learned from that. |
| MP: | But it's different when government is doing the selling I guess in developing countries. So it's a real power issue and I guess in the UK we think we are a mature democracy and therefore we are probably quite open about, actually very open about any [inaudible 1:20:31] buying whatsoever. There's probably not much different, there can't be much of |



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| | <p>this British island that's left, it's all gone [inaudible 1:20:39]. But I guess in a lot of developing countries then it's not a democratic process, but it's saying actually the locals didn't know that it's been sold and somebody turns up with a bulldozer or whatever. [inaudible 1:20:52].</p> |
| IH: | <p>But also the question is how do you trust the owners of the land [inaudible 1:20:59], but of course local communities may have use rights to that land [inaudible 1:21:03].</p> |
| AB: | <p>Even land in the scale of things, we had a big workshop in April this year on the competition for land in Africa and we had representatives from DRC, Democratic Republic of Congo and they pointed out that yes, the local chief is the person that determines how that land is used right up until its mineral rights and mining trumps everything and at that point he no longer has any say in how the land is going to be used, it's the government. So there is a hierarchy of rights and ownership that comes into play as well.</p> |
| IH: | <p>Whereas ownership is a very [inaudible 1:21:47], so actually thinking that you're going to be able to work out who owns the land in a simple way may be [inaudible 1:21:56].</p> |
| RF: | <p>Mongolia is a classic example of that because supposedly 80% of the country is communally owned, so the pastureland [inaudible 1:22:04]. So again it is difficult to actually render and so I can appreciate you needing that data.</p> |
| LJ: | <p>Yeah. I think for me the thing is that the fact that land ownership can change suddenly, it's something that we are aware of, I mean it happens all the time in the US [inaudible 1:22:36] government, you own that land until the government decides Iowa is coming here and your land is worth \$25,000 and there you go and the same with chiefs and the DRC. But the question is if we can understand who owns it, whatever the pressures on that land might be into the future we can understand when those land transitions might actually happen and understand the true probability of that happening, right? I mean we see maps all the time of like 'Oh agriculture is going to just happen here and mining is going to happen here', well in some of it might because it's in a place where mineral rights trump everything else and the pressure is going to be high enough or whatever, but you know, we also know that when somebody says 'Agriculture is going to happen here' that's not going to happen, right? So it doesn't negate the need to...the fact that land ownership can change and be taken doesn't negate in my mind the need to actually know in the here and now who owns it because it helps us understand who might own it into the future.</p> |
| AB: | <p>Because I've said there's another reason...actually I'd rather use the word tenure, that land tenure is important not just sort of predicting how it might change but actually in terms of conservation. The relationship between biodiversity conservation and rural people has not been very positive in some places, many places. But actually there is a real chance here if you can understand the land tenure, particularly if it is traditional or communal or any of those indigenous or some of those values where they are quite insecure in the face of these major land grabs as they are often called. There are some alliances actually to be made between conservation interests and the interests of local people and that would be very unusual, actually, but also very powerful too I think. So I think that's a really important feature, land tenure and the governments is a critical element.</p> |
| MP: | <p>So if you know about property prices, if you like, [inaudible 1:24:37] break down ownership into different [inaudible 1:24:40].</p> |
| AB: | <p>Yes, a range of different rights.</p> |
| MP: | <p>You can begin to understand.</p> |
| KM: | <p>I just wondered if there's an element of...as well as rights a kind of responsibility as well, because often those...so in terms of the sort of smallholder farmers and so on who may well have the right, they may not have the ability to maintain the respons...they are responsible, they should have responsibility but they may not have the capability to maintain a water system or farm the land in a way that is most effective for biodiversity</p> |



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| | conservation or whatever it might be. So whose responsibility does it become? Does it become higher up the supply chain or does it become policy agenda and governments or NGOs, third sector, who then, even though they may have ownership or may not, where are the pressure points that we should actually be applying to maintain that sort of underlying natural capital or biodiversity or whatever it might be? I don't know how that might be able to be resolved. |
| MP: | Ownership is a mixture of rights and duties, so you can't...so if you begin to start...if you like every right has a reciprocal duty so ownership is about what you can and can't do with an asset, it's about it's a property right if I'm enjoying a benefit stream and of course there is a duty on other people not to interfere with that benefit stream but also there are limits on what you can do. So in a way ownership is far from pure in terms of law about pollution or law about soil. I was struck about the point about good environmental condition and so if you receive funds [inaudible 1:26:30] agricultural policy you then have some cross compliance requirements in order to entitle you to receive it, okay minimal, but that's not quite the point. The fact they're being enforced [inaudible 1:26:41] quite comforted by that. So that's the complexity of the package that we are talking about here in rather sort of simple terms and saying 'How is it owned?' Because I guess even within a developing society there will be communal ownership of some sort, there may be imposed on top of them some sort of formal legal system and it may be quite different. So different people have different views about ownership. So asserting ownership would be a political thing that might actually be sort of contradictory to achieve certain things. |
| AB: | To some extent it does go hand-in-hand with good governance of the land though, because that's certainly the received wisdom from the soil conservation community is that you're more likely to protect it if you own it than... |
| MP: | The long-term scenario. |
| AB: | Yes. It's in your interest to continue to reinvest in it and protect it. |
| JH: | Or if you're in the agricultural one we have some great non-compliance with people with motocross tracks in their fields, golf courses and caravan parks and all sorts of stuff. |
| AS: | So could I just ask on a different question again, [inaudible 1:27:55] is in that position I would imagine, given the monitoring of agricultural systems and so on, to act as a test case or a benchmark for other systems. Because all of the data that you're downloading globally, there's huge amounts of it, maybe there's a case for having a sort of slightly more local scale. I mean I don't know to what extent you're worried about biodiversity logs in the European Union? |
| AB: | Enormously, enormously. I mean looking at hedgerows and things that came up earlier a lot of that is part of it. |
| AS: | And so to what extent do you have datasets? As Jon was saying you can't compare [inaudible 1:28:42] 2005 and 2009, can you do that with bits of Europe? |
| AB: | Yes with some of it we can. You run into the problem that we had before of some of the data are sensitive and we're not even allowed to give you that. I mean we have information...fire was one that we were talking about earlier in Spain and Portugal, we have datasets which show the location, the size, the timing, the extent of every fire in Portugal, Spain and throughout the Mediterranean. Then we have to doublecheck it because those countries have claimed money from the European Union to repair the damage of the fires and they will say 'We lost X hundred thousand hectares of forest.' We then check it and say 'You've lost X minus or plus.' |
| LJ: | Is that what happened? The plus? |
| AB: | I couldn't possibly say. But there is a check. We've done the same with windthrow when there were heavy windstorms in Eastern Europe and there were claims for recompense. But the agriculture thing we are taking into eastern Africa on the food security side, so it |

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| | then comes back to using the techniques that have been developed for crop yield estimation in Europe and they've been done for economic reasons in the European context and then transferring it to eastern Africa for a food security perspective. But there you find that the data that are fed into the agrometeorological models in eastern Africa aren't as good because the basic input data that we get from ECMWF in Reading for example, it doesn't work quite as well in eastern Africa, so everything is a little bit fuzzy. But it is transferable. Cadastre, we use the high-resolution imagery to check the land parcel identification system as it's called for the farmers' declarations. That is transposable technology to Africa to help people build a cadastre which doesn't exist. |
| AS: | So I'm a bit confused between what you're saying and what Jon's saying, there's a disjoin, what's the thing that isn't available from your point of view? |
| JH: | Well I don't understand the European situation well enough to compare but generally speaking for the globe, the images that were taken, [inaudible 1:31:20] in Olson's work in 1983 at a particular resolution cannot be compared with images 10 years later, 20 years later, 30 years later, now 40 years later because the resolution has changed and everything else has changed and so you cannot put them in a row and say 'This change has happened in this place.' |
| AB: | He's right, you just can't do it. |
| AS: | Who could do it? |
| JH: | But there are ways...good question. There are ways to correct it. So in Europe for example there would be not only satellite imagery but there might be images taken from aeroplanes for example which you can manually lay out and you can come to correction factors. And possibly in Europe, I think it probably is true, I don't know when the first 30 m kind of imagery came out but then there would be quite a long series of those I would imagine. |
| AB: | There are, yeah. |
| JH: | So at least the last 20 years. And if there's an interest in Europe I suspect they could roll out the expertise to build these really boring tools. |
| AB: | They are doing it, they're building the boring stuff. I mean there's mapping...200 big cities are being mapped at 1 m resolution for exactly that, to look at minutiae change. |
| JH: | But it's not happening across the globe. |
| AB: | It's not global. |
| MR1: | But will there be long-term consistency? Satellites have a limited lifespan and all that and so the value of long-term to have data where you can really study small trends. |
| AB: | We were having that discussion earlier and I was advocating the importance of things like the Sentinel and the Landsat programme and one or two others. I mean there are 90 flying but I wouldn't trust most of them. But some of them have been very, very carefully cross calibrated so that you can take a measurement from that one and you can compare it to that one. So things like drift, you know changes in orbital overpass have been taken out of the system. You take standardised targets in the...I was going to call it the living desert, but it's a test site in the Sahara which is consistently taken...every single overpass is taken, it's been characterised using ground radiometry and you get a very exact measurement. But it's a handful of satellites that give that quality. |
| SO: | With my colleague Tom Spencer we have in Geography...we inherited it or took on [inaudible 1:33:56] University collection [inaudible 1:33:58], fantastic coverage of the UK and goes back to...now I should know this... |
| MR1: | The 1930s wasn't it? |



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| SO: | We had meetings about it but maybe the 1920s... |
| AB: | It's possible, yeah. |
| SO: | I remember using it when I was a very low academic and I remember it used to be stored somewhere on the New Museums site in huge filing cabinets, you used to have to sort of plough through all these endless images of fields and things [inaudible 1:34:28]. But the trouble is it's a fantastic collection from a number of very dedicated supporters, but actually to get it in a state that makes it usable for people is really difficult and expensive. So in some ways it's an underused resource if there's still a use for some of those sorts of [inaudible 1:34:56]. |
| MR1: | It should be digitised surely? |
| SO: | Well it can be but it costs and... I mean it is slowly in the process of being made usable but whether that will last I'm not sure [inaudible 1:35:17] at the moment. I think as a historical collection which I'm quite intrigued [inaudible 1:35:25]. |
| AB: | Tremendously valuable. I mean we were looking earlier at this imagery of the [inaudible 1:35:33] in 1972, satellite imagery there and you've just got wall-to-wall forest and then you move into the 80s and you can see where the road goes, then you see the dam being built and then you see the flood's started and you can see where the original dam planners thought it would stop and it didn't, it just went on and on and on and it flooded to 2,500 km of forest. But you can follow that whole history and it's become more valuable with time, much more valuable. If only we'd looked after the Landsat archive properly in the 70s but we didn't. We are desperately trying to pull it back now, there are datasets in receiving stations in some very troubled parts of the world that are being recovered and you bake the tape for an hour at such and such a temperature and then you up the temperature a bit, and then you let it cool, and then you run it through once. We're trying desperately to recover this old stuff. |
| LJ: | So one comment I want to make based on this kind of global versus regional and utility of a particular place and the market for doing that is...one paper that I should have sent around that I wrote in 2008 with a colleague and we just...at this time, now it seems amazing that they did that but we didn't think anything of it when we called them. We called all the world's high resolution satellite providers and we said 'Can you send us the bounding box of all the imagery you've ever taken?' and they said 'Yeah, sure, why not' and we're like [inaudible 1:37:08]. But we didn't think that was surprising, right now if I called up all the world's high resolution satellite providers and asked that they would be like... They'd probably call the national security [inaudible 1:37:17]. But what that allowed us to do was see the global accumulation of unique places that we ever had high resolution satellite imagery of and map what it would look like if we [inaudible 1:37:33], if we'd taken those images optimally to cover the earth surface, right? And of course you know what those two lines look like, amount of unique land surface that was covered went something like this and [inaudible 1:37:45] onlining of new satellites and how we could have done went like this, right? So it's just there's a market for taking pictures of Denver or LA or Cambridge or whatever and we keep putting more and more capacity up there. We keep lowering the price, we keep increasing the resolution, we keep taking pictures of the same place and so it's through...and so what both of them have said is true, we have no idea even at a course resolution about a global change of land cover but we can do an unbelievable job of Cambridge, right? Unfortunately for most of the people sitting around this room we find that oppositely aligned with our interest, but that's not misaligned with market interest so you have to ask...and this is where governments come in of... That's why the Landsat programme and I completely agree with Alan the Sentinel programme is hugely, hugely valuable and I completely agree. I get irked when everybody says...people get so excited about 25 cm resolution, you think to yourself 'Well, yeah, I've seen Cambridge.' Yes, we'll be able to map cities and we'll be able to tell where the sidewalks went or whatever but what we really care about is that long-term history where |



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| | you can at least see the dam going in, you can then see [inaudible 1:39:21], and that's what we need, we don't need to be able to see the veins on the leaves of you know... |
| MP: | I wonder if we could have land systems? So I guess in the past and I don't know that anybody does it nowadays and I was talking to someone the other day and she was talking about when people came from France and actually interested in an area of land as a system. And it wasn't any particular discipline but they were interested in, I guess, the land use and the economics and the social and all these other things and that happened in a particular place. What struck me was that we've got all this data but no structure to it and then so there's a logic to say well I think we need some sort of structure to say well it is going to focus our attention on something. And then I guess once you've got your focus of attention, because we tend to focus attention on Cambridge, then it all...so you've got that [inaudible 1:40:13] together and then we can have a very complete story. So if you had...we go back and talk more about land systems we begin to divide the world up into some sort of structure and then you can say 'Well okay, let's get all the information that relates to this sort of place', and we could also have people on the ground that begin to understand what the society is like and what the land ownership is like and the tenure and [inaudible 1:40:35]. So you have a sort of major, I guess, of pressure, it seems to me the sort of gross data can tell us something about the pressure to change but not about the way in which it's going to work out in a particular place. So you then combine it within that particular system because that system has something homogenous, there's either going to be some continuity across that system - I'm not sure what the system is - but that local area. Then it means you don't need to know everything about everything, what you need to have is representative data that tells you what the typical farms are like in that area, what's the standard sort of rotation, how do farmers make decisions, what's the nature of tenure and so on and then you can begin to put that all together for a particular place. So then you could use your data and then try and work out that...so to tell a story about a particular place. |
| AB: | Yeah, would a watershed be a system? |
| MP: | Yes. I mean I guess...so within the UK some years ago the Countryside Commission and English Nature I guess it was sort of went out to try and produce a map of car parking [inaudible 1:41:49], but the different sorts of places and then government said 'Stick it together.' But that I think had got quite similar sorts of maps anyway, so I think actually there wasn't [inaudible 1:42:00] to get them to go together. So there's a fair amount of agreement that is based on geology and hydrology, but also human settlement and ownership and things. |
| SO: | [inaudible 1:42:13]. |
| MP: | [inaudible 1:42:19] than these sorts of local areas. |
| SO: | There was a great passion in the 1970s for taking a particular [inaudible 1:42:30] and sort of mapping all the flows of everything [inaudible 1:42:42]. |
| IH: | But you need some structure. Actually we can talk about London, we can talk about ownership, so maybe that actually if you like the physical geography doesn't matter so much, I mean it's the human and economic geography that determines what's important in particular places. |
| MP: | Back in Australia in the 80s there were still sort of manuals of land systems, they still used those and they still do, but they're used to thinking in those sorts of terms and that would provide a sort of structure I think. |
| AB: | Can I just...? An observation. So we tried to look at whatever you want to call them, catchments, watersheds, whatever and we did a lot of work funded by the MacArthur Foundation who are interested in...that's their view of the world and the reason I'm raising it is because of the data issue. We managed to get...you know map obviously relatively straightforwardly the landscape and the watersheds and the catchments, but actually |



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| | there is no data. The reason there is no data is because data is collected at political level. If you take it nationally it's collected in provinces, it's collected in districts, whatever they may be. Poverty data, biodiversity data is all collected according to a different framework so you can take a watershed with a very logical kind of approach to management but you can't actually disaggregate the data into that level of that system. |
| MP: | [inaudible 1:44:35]. |
| AB: | Well only if you've got the original data. I mean if you've got just someone's drawn on a map 'Here be dragons', it's difficult to know where the dragons actually were so you can disaggregate the data. It's a nightmare actually and your results just become very slight. |
| MP: | Just a thought prompted by the last thing - so we've been talking about all this data is going to be used for virtuous reasons and historically this sort of data has been used for colonial structures, it's been used for various nefarious purposes. I mean if you look at the mapping of 17 th century Ireland or Scotland after the Rising and the development of the Domesday Book. There is an issue then [inaudible 1:45:31], about governments around all this data and we've tended to assume that transparency has been [inaudible 1:45:38]. |
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