Closing Remarks

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I would like to start these closing remarks by expressing my sincere thanks to the organizers of this event. CIAT is proud and honored to be associated with this symposium. We would also like to extend our thanks to our hosts, to all the visitors from other countries and all of the staff here, and for a very entertaining and enjoyable evening last night. It was very special.

Coming at the end of the seminar, I fear that I am not going to say anything new or different. This is especially true when it is recognized that I am not expert in GIS at all - although I would have to say that the last two days have been very informative and I know a lot more about the subject today than I did when I arrived. I hope that many of you will feel the same way. I would like to congratulate all the speakers on the high quality of their papers and presentations.

I want to take a few minutes to reflect on the overall challenges, emphasizing one or two points, and trying to put our work on GIS in the broader context of development. The title of the symposium was the "Agro-Environmental Issues," and I will try and capture what I see as the real essence of both the "Agro" and the - "Environmental" parts. The world is still facing very substantial population growth, and there are major issues of environmental degradation to consider. With the growing population, we will simply have to produce more food. Because of the environmental degradation, we are probably going to have fewer resources with which to achieve this objective. This, in a nutshell, is our challenge.

Let us start with the question of feeding the growing population, the first of these two challenges, the "Agro" part. The world population continues to increase. In 1940, which is not so long ago, there were 2 billion people in the world. A few weeks ago, we passed 6 billion. In other words, in the entire history of mankind, it took up to the year 1940 to get to two billion and in the next 59 years, to 1999, we passed six billion. There are various projections, but they all indicate that we will be in the order of nine to ten billion by the middle of the coming century, another 50 years. While the rate of increase has slowed down, we are starting from a big base. Even a small percentage increase of six billion, is still a very large number, so we are going to have very substantial absolute increases. I have drawn here a picture of food production in the world, starting from about the time of the beginning of agriculture, let us say, in the year 10,000 B.C. There is an interesting fact that comes out of this: if we want to continue to provide an adequate supply of food over the next 50 years - by "adequate" I mean, the same per capita availability of food as we have today- then clearly we will need to have an enormous absolute increase in food production. In fact, that increase in food production over the next 50 years will actually be more than the amount of food that we have ever produced in the history of agriculture. Those people who think that the world food problem is solved, have got it wrong. That is the first challenge I see in the Agro-Environmental issues.

The second challenge is the question of environmental degradation. We are not going to have more land, soil and water in order to produce that extra food. At the very best, if we are very careful, we will have about the

same amount as now, but more likely we will have a bit less. There will be increased urbanization and industrial uses for land, as well as other competing claims on the resources used in agriculture, especially water. So, however carefully we look after the resources, it seems likely we will inevitably have less of them. This will make the challenge of producing more food with fewer resources, even bigger. Stewardship of the resource base involves a number of levels. It involves what kind of cropping systems we have and their effects on the environment. It involves what kind of farming systems we adopt and their effects on the environment. And it involves the management of whole watersheds.

It is in addressing this challenge of producing more food with less resources, and at the same time protecting the environment, that GIS methods are a particularly important and powerful new tool. We are now standing at the beginning of the new century with a big challenge, but fortunately with new tools. These tools will help us to produce the extra food without environmental degradation.

If we are going to have more food and fewer resources, we are going to have to increase the productivity of agriculture and intensify it. Anyone who says we should not intensify is saying the world should suffer from hunger on a massive scale. But we have to intensify agriculture in a sustainable way. For me, in simple terms, that is the real Agro-Environmental challenge.

There are lots of new tools available, obviously GIS is one, but there are a lot of other new technologies. I think we are on the verge of a biological revolution, which will bring with it new possibilities for increasing food production through new genetic techniques. One of our challenges in GIS, I think, and not one I have heard a lot about in the conference, is how do we complement these new genetic advances with our expanding capability in GIS. I think there is a potential for complementarity in understanding genetic makeup and its spatial distribution, both of the plants and the insects and diseases that affect them. I think GIS can contribute to the expansion of new genetic techniques in agricultural production. It has been mentioned often - and I think it was one of the key points raised by Andrew Skidmore in his opening remarks -that there is a need for participation by farmers, decision-makers and others, so that research is not conducted in isolation. This will be an essential ingredient if we are to exploit the full complementarities between GIS and associated fields of science.

The knowledge that we have accumulated through the application of GIS in addressing agro-environmental issues, can be extremely useful in the case of disaster relief. Let me illustrate with a recent example at CIAT. You will recall that on October 31 last year, a major hurricane went through Central America, with tremendous loss of lives and destruction of crops especially in Nicaragua and Honduras. Within 48 hours, staff from CIAT were making a valuable contribution to the emergency disaster relief efforts, based on the extensive range of GIS information we had built up for a range of variables in Honduras. All that information has subsequently been published and is available on a CD. In addition we also have available an atlas of sustainability, another product of our work in GIS. The disaster relief aspect has been an important by-product. I suspect that when we initially started to work on GIS for agriculture, no one thought that disaster assistance might be an application. However, I believe that, as a result of this experience and a similar project in Rwanda some years before, when designing future GIS projects, we might well keep in mind the potential value that information has for natural disaster relief.

In the last few days we have seen a large and rich range of models and experiences. Again our thanks and congratulations go to JIRCAS for taking the initiative in organizing an international symposium to bring some of these experiences together. It is important that we share, because there is a risk of duplication. There is a risk that somebody has developed a database, which applies to a certain region with certain variables that relate directly to our interests. Someone else has done the same thing. At that point, not only would we have wasted resources but, as Dr. Skidmore noted, we risk creating inconsistency between these different sources. I was struck by his example, when he drew on a number of databases to get the same information and found he was getting different pictures and maps by asking the same question of a number of databases. I was reminded that until the 1930s and early 1940s, there were no common standards for developing national income accounts. It was impossible to compare the gross domestic product (GDP), in New Zealand with a comparable number for

Indonesia or Japan, because the accounting systems the countries were using were all different. What was called consumption or investment or expenditure at the national level in one country was different in another country. In the 1940s there was a major international conference and the development of an agreed set of standard systems for national income accounting emerged. While there are many advances that we can still make to improve the way we do national income accounting, at least there is a standard uniform procedure agreed upon by all countries. So economists using accounts from one country can be reasonably assured that the definitions and basis for these data are the same as in other countries.

One of the aspects of international collaboration that may become important in the future is the matter of intellectual property rights. There has been a lot of reference made in the last two- days to sharing data. In many cases it is reassuring to know that the data are in the public domain. But I suspect there will be cases where that is not true. A lot of money and time may have been invested in collecting a particular data set which may not automatically be publicly available. I think that this issue in GIS work will become more and more important.

In the last few days, besides the wide variety of experiences from many countries, we have also seen the depth and extent of the work in GIS of the scientific community in Japan. I think Japan is well placed to continue to play a leading role.

I want to add a note of caution about the use of the concept of land use suitability. Clearly some notion of what use land might be suitable for can be a useful element in taking decisions. Individual farmers do this, every season. They know that this part of the farm has well-drained, sandy soils that dry out quickly so they need to plant, let us say, short-season crops. In another area they may plant perennial crops because of the natural contour and spoil characteristics. In short, farmers are constantly thinking about what land is suitable for what purpose. However, what is suitable at one point in time is not necessarily going to be suitable in the future. It is reasonable to expect that the optimum pattern of land use, rather than being static will change as new technology becomes available, and when prices change. If you were an agronomist doing studies of the soils and the temperature regimes in New Zealand, you would almost certainly conclude that New Zealand is not suitable for growing bananas. However if the price of bananas were to rise from one dollar to 30 dollars kilogram let us suppose, then, that it might well become profitable to grow them in New Zealand. If someone had done a study of land and water use in the area of the new Kansai airport or in Hong Kong, they probably would not have identified that part of the sea as suitable for an airport. The technology has changed, land prices in other areas have changed so that now we can build an airport in an area that might never have been classified as suitable for airports! Many soils may have high aluminum levels, causing aluminum toxicity in plants. You would say that these soils are not suitable for pastures. But if we could develop pasture varieties that had high tolerance to aluminum, we could well use those soils for pastures. In other words, if the prices or technology change, what we think is suitable now may be different in a year's time. For these reasons, I caution placing too much emphasis on land use suitability studies.

I was taken by the comment at the end of the discussion about "who is benefiting from all of this GIS effort". I think this is a very relevant question. We should be constantly asking ourselves about the social impact? What is the consequence of this investment in GIS research and data collection on people's lives? We are talking about working in developing regions. Development at the end of the day means improved human welfare.

Finally, being an economist, I want to mention the value of information. Unless we have some notion of the value of information, then we are going to have difficulties establishing priorities. We have heard that many of these studies can be expensive. We only have a limited amount of resources. If we do a study on soil salinity, that means we can not do a study on rice in some other region. We have to set priorities. There is no escaping that economic fact of life.

Let us start from where we are now, in some initial state with initial information, let us call that A. On the basis of that information, we can make certain decisions. The consequence of that decision will have a certain outcome and we can assign some value to that outcome. If we start from the same initial state of information, but

we get new data from a new GIS study, that expands our knowledge. We have not just quantity A but, added to that, quantity B of data. It was not free. We had to spend resources to get from A to B, with the cost being, let us say, C. With that, we make a new decision and that will have some value. The question is "what was the net benefit of all of this?" It was the difference between the decision made with the new information minus the decision made with the old information. How much better is B over A? It has a certain value from improved decision-making. To get the net benefit, we need to subtract how much it cost. If the net benefit is 10 dollars and it cost us 20 dollars to get there, we may not want to do that. Only once in the 2 days did I hear some discussion on the value of information. I believe that was in the presentation on the fertilizer work in China, where there was an estimate made that, given the improved information base developed as a result of that study, more effective use could be made of fertilizer in Chinese agriculture. That would have substantial economic benefit, which I recall was some 4 billion Chinese yuan, I am sure that more than paid for the GIS studies. These types of calculations estimate the value of information. The people who fund us to do GIS studies should be asking that question. There is a tendency with techniques like this - and economists are guilty of the same - of concentrating on the tools and not on the problem. In other words, we have GIS and remote sensing. Are not those clever tools? And with them, we can generate lots of data. Then the question is, what can we do exactly with these data? What information are we going to derive from the data? Who is going to use them? This approach starts with the tool, we could collect some data, and with the data, extract some information out of it. That information probably will be useful to someone.

In my judgement, the correct way to approach this is the other way around- we must start with a problem. I like the study from Thailand that started with the issue of salinity in rice, a specific problem which had been identified. With that, we can come in with GIS and remote sensing tools. We can generate some data. From these data, we can get specific information useful to the problem of salinity and the output can be tailored to the particular client or user of the information, and contribute to a solution. In short, I think it is important to have a problem-focused approach to our work in GIS and not just a tool-based approach. I am sure that every researcher would like a remote-controlled helicopter. After the impressive presentation today on this tool, I suspect that my staff at CIAT will be including one in their application for to the capital budget next year. However, let us remember that what we are ultimately trying to do is to ensure that there is enough food for everybody, to ensure that people can buy food, that the world population is fed. It is people's lives that really matter at the end of all of this.

Let me conclude with a story from Japan. Every year there is a famous hot-air balloon race from one end of Japan in the north to the bottom in the south. Last year New Zealand entered a team for the first time. The New Zealand team were doing quite well. Unfortunately, however our New Zealand team did not have good GIS maps. This was a problem of collaboration of countries on GIS. So they got lost halfway through the race. Their only possibility was to ask someone for directions. They lowered their balloon towards a farm, a traditional Japanese farm with rice paddy. They started calling out for help. Finally the farmer came out to see what all the noise was about. They told the farmer, "We are lost. We are in the great Japanese balloon race. We were winning and now we are lost. Can you please tell use where we are?" The Japanese farmer looked up at them and then down on the ground, repeating this several times. "You're 37.263 meters above my head", he finally replied. The New Zealanders were very happy about the information. After they had gone a little further one of the New Zealanders said, "That Japanese farmer was a GIS expert."

The other said, "No, that can not be true at all."

"No, I am sure that he was a GIS expert."

"How do you know?"

"Because he gave us information that was absolutely precise and completely useless."

I want us to continue our work in GIS, generating information that is reasonably precise but very, very useful.

Thank you.