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A conceptual framework for assessment of the benefits of a Global Earth Observation System of Systems: An example in forest fire management

S. Fritz1,

N. Khabarov1

R.J. Scholes2,

M.Obersteiner. 1, ,

J. Bouma3

B. Reyers2

1. International Institute for Applied Systems Analysis, Austria

2. Council for Scientific and Industrial Research, South Africa

3. Institute for Environmental Studies, The Netherlands

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The aim of the Global Earth Observation System of Systems (GEOSS) is to improve the information available to decision-makers, at all levels, relating to human health and safety, protection of the global environment, the reduction of losses from natural disasters, and achieving sustainable development. Specifically, GEOSS proposes that better international co-operation in the collection, interpretation and sharing of Earth Observation information is an important and cost-effective mechanism for achieving this aim. While there is a widespread intuition that this proposition is correct, at some point the following question needs to be answered: how much additional investment in Earth Observation (and specifically, in its international integration) is enough? This

leads directly to some challenging subsidiary questions, such as how can the benefits of Earth Observation be assessed? What are the incremental costs of GEOSS? Are there societal benefit areas where the return on investment is higher than in others?

The Geo-Bene project has developed a ‘benefit chain’ concept as a framework for addressing these questions. The basic idea is that an incremental improvement in the observing system (including its data collection, interpretation and information-sharing aspects) will result in an improvement in the quality of decisions based on that information. In turn this will lead to better societal outcomes, which have a value. This incremental value must be judged against the incremental cost of the improved observation system. Since in many cases there will be large uncertainties in the estimation of both the costs and the benefits, and it may not be possible to express one or both of them in comparable monetary terms, we show how order-of-magnitude approaches and a qualitative understanding of the shape of the cost and benefit curves can help guide rational investment decision in Earth Observation systems.

We show with an example in forest fire management system how improved satellite and in-situ based weather observation systems might help to reduce forest loss, human casualties and destruction of economic capital. In this paper, we develop and apply a methodology to assess the benefits of various weather observation systems on reductions of burned area due to early fire detection. In particular, we consider a model where the air patrolling schedule is determined by a fire hazard index. The index is computed from gridded daily weather data for the area covering parts Spain and Portugal. We conduct a number of simulation experiments. First, the resolution of the original data set is artificially reduced. The reduction of the total forest burned area associated with air patrolling based on a finer weather grid indicates the benefit of using higher spatially resolved weather observations. Second, we consider a stochastic model to simulate forest fires and explore the sensitivity of the model with respect to the quality of input data. The analysis of combination of satellite and ground monitoring reveals potential cost saving due to a "system of systems effect" and substantial reduction in burned area. Finally, we estimate the marginal improvement schedule for loss of life and economic capital as a function of the improved fire observing system.