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Final report of the Group of Experts

**Report of the fifth meeting of the Group of Experts  
of the Committee on Science and Technology**

Note by the secretariat\*

Addendum

**Guidelines for early warning systems**

*Summary*

Desertification can be seen as an environmental degradation process that contributes to an increase in the intensity, frequency and impacts of natural hazards. Early warning systems have been recognized as key components of disaster reduction strategies and action plans at all levels, and because the desertification issue is nowadays embedded in existing food security and drought warning systems, a desertification early warning systems should be put in place. Such a system needs to reflect the appropriate spatial and temporal scales for detecting desertification.

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\* The submission of this document was delayed due to the short time available between the fifth session of the Committee for the Review of the Implementation of the Convention and the eighth session of the Conference of the Parties.

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## **I. Introduction**

1. The importance of desertification as an environmental concern, and its impact on countries experiencing drought, especially in Africa, was stated at the Rio Earth Summit in 1992 and prompted the negotiation of the United Nations Convention to Combat Desertification (UNCCD). In the context of the UNCCD, benchmarks and indicators, desertification monitoring and assessment and early warning systems were identified as integral components of the holistic approach to understanding the casual factors and spatio-temporal characteristics of drought and desertification. Early warning systems for drought and desertification provide a useful framework for promoting comprehensive data collection and analysis, as well as the formulation and implementation of intervention measures.

2. The Conference of the Parties, by its decision 15/COP.6, in recognizing the important role played by effective early warning systems in combating desertification and mitigating drought, requested the Group of Experts of the Committee on Science and Technology to undertake its work programme in this field, and to evaluate and recommend guidelines for both short-term and long-term early warning systems for combating desertification. The Group of Experts has been carrying out this task and has prepared the report contained in this document.

## **II. Early warning systems and natural hazards**

3. Desertification can be seen as an environmental degradation process that contributes to an increase in the frequency, intensity and impacts of natural hazards. The numbers of disasters arising from natural hazards have been increasing all over the world in recent years, affecting thousands of people and causing considerable economic impact in developing and developed countries. Poor societies, with a higher vulnerability to hazards, are especially sensitive to impacts of natural disasters in terms of deaths, starvation and diseases. The development of developing countries is also hindered by the economic losses generated by natural disasters, which sometimes equal the national growth gains.

4. A further increase in the number of natural disasters is predicted over time due to climate change and increasing human vulnerability to hazards as a consequence of population growth, migrations, development processes and environmental degradation

5. Early warning systems are recognized as a key component of disaster reduction strategies and action plans at all levels, and are among the most cost-effective measures to reduce the impacts of natural disasters. Moreover, the implementation process of Agenda 21, as well as the follow-up processes to the 2002 World Summit on Sustainable Development, touched upon the importance of early warning systems in the framework of sustainable development.

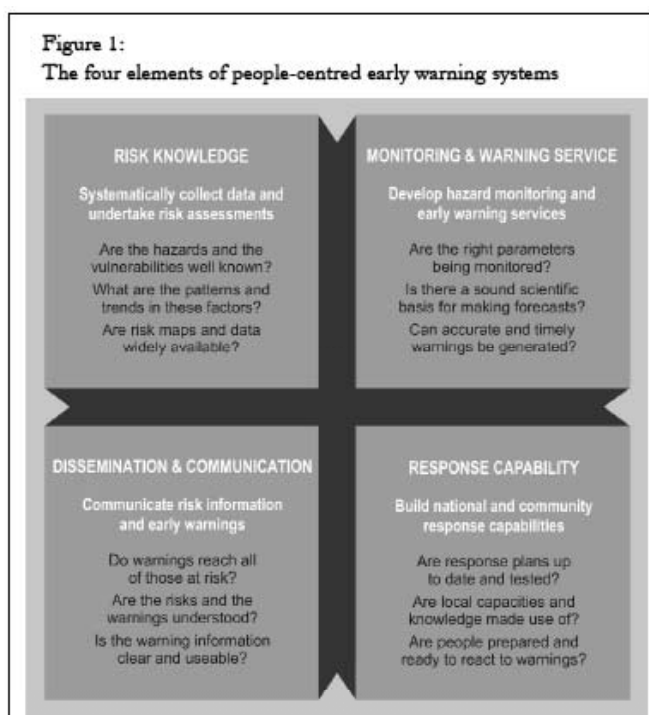
## **III. Definition, objectives and components of early warning systems**

6. The International Strategy for Disaster Reduction (ISDR) defines early warning as “the provision of timely and effective information, through identified institutions, that allows individuals exposed to a hazard to take action to avoid or reduce their risk and prepare for effective response”.

7. The objective of an early warning system is to provide information to individuals and communities at risk to make informed decision and take action, in sufficient time and in an appropriate manner, in order to reduce the possibility of personal injury, loss of life, damage to property and the environment, and loss of livelihoods.

8. Effective early warning systems of natural disaster comprise four inter-linked components (figure 1): risk knowledge, monitoring and warning service, dissemination and communication, and response capability.

**Figure 1. The four elements of people-centred early warning systems**



Source: ISDR Platform for the Promotion of Early Warning.

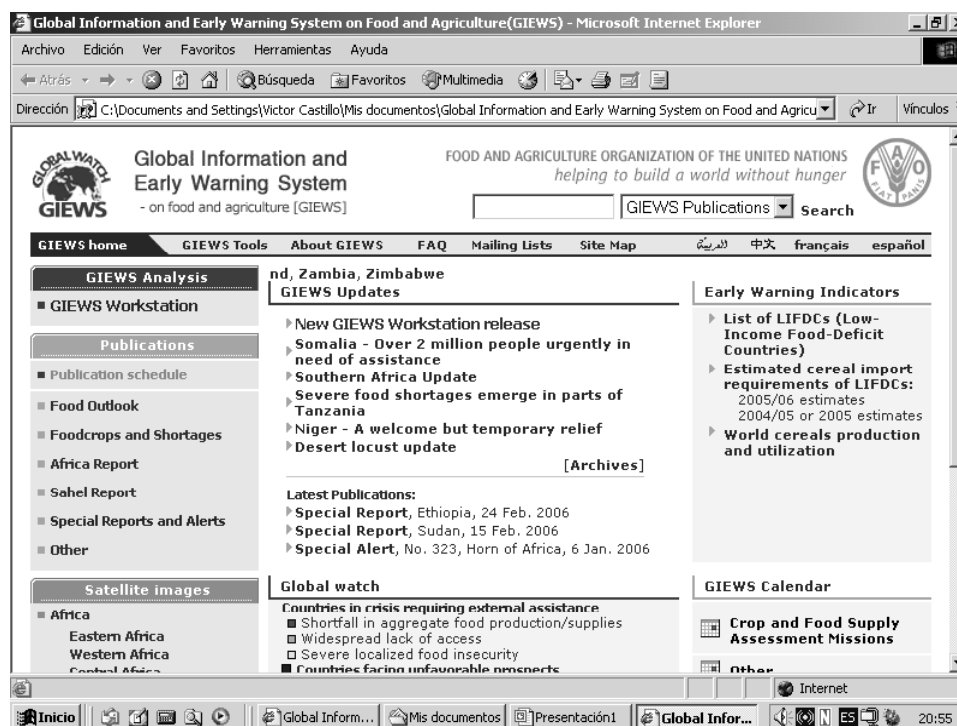
9. Risk knowledge is based on the joint analysis of natural hazards and human vulnerability. It requires systematic data gathering and analysis at appropriate spatial and temporal scale, and the study of the dynamics of vulnerability driven by natural or socio-economic forces. The monitoring and warning service aims at making accurate and scientifically sound predictions and forecasts in a timely fashion; the design, implementation and maintenance of an adequate monitoring network and facilities to collect hazard parameters and control variables are the cornerstone of this component. The goal of the dissemination and communication component is to provide information on potential impacts; warning messages should be clear and useful, including appropriate response-oriented recommendations. Finally, the response capability component aims at developing and testing preparedness programmes that ensure safe behaviour of communities and options to avoid and reduce damage.

## IV. Operating food security, drought and desertification early warning systems

10. A review of early the warning systems in the field of food security, drought and desertification that are accessible through the ISDR platform for the promotion of early warning systems (<<http://www.unisdr.org/ppew/>>) or other Internet sources, revealed that an early warning system specifically oriented to desertification does not exist. The desertification issue is embedded in existing food security and drought warning systems.

11. The first early warning systems for drought and food security were established in the late 1970s as a response to famine caused by dramatic drought that occurred during that decade. They were based on a close relationship between food insecurity and the meteorological trend of the year. Agrometeorological evaluation models of crop yields were the main forecasting instruments (figure 2).

Figure 2. Global Information Early Warning System web page



12. Table 1 shows the objectives, modules and products offered by two of the most widely used early warning systems for drought and food security, as well as those offered by a warning system developed in Spain to detect desertification risk at national scale. The systems explored are organized in various different modules but all these modules can be grouped in the four components of early warning systems:

(a) Monitoring and analysis of data, supported by online geographic information systems (GIS) and crop models through modules such as Geoweb or the download program WINDISP (the Global Information Early Warning System of the Food and Agriculture Organization of the United Nations (FAO)), weather analysis (rainfall indicators), vegetation

analysis (normalized difference vegetation index (NDVI) comparisons), crop calendars (crop water requirement (CROPWAT) model and other models), and streamflow models (famine early warning systems (FEWS)).

(b) Risk analysis – information and alerts on hazards, spatial distribution of hazards, risk maps including vulnerability analysis i.e. hazards effects on households and population.

(c) Exchange and diffusion of information – clearing house mechanism concept, through mailing lists, online databases, publications and reports, bulletins.

(d) Decision support – analysis of risk maps and development of emergency scenarios, modules of contingency and response planning.

**Table 1. Characteristics and organization of some early warning systems relating to famine and drought**

Name and organization	Objectives	Scale	Main modules	Description
Global Information and Early Warning System (GIEWS) on food and agriculture. Food and Agriculture Organization of the United Nations < <a href="http://www.fao.org/GIEWS/">http://www.fao.org/GIEWS/</a> >	Warning of food crises so that timely interventions can be planned and suffering avoided. Monitoring food supply and demand in all countries of the world on a continuous basis. Providing information on global production, stocks, trade, export prices. Sending rapid food supply and demand evaluation missions to affected countries. Report to the international community	Global Regional National	Crop monitoring	Based on rainfall estimation derived from Meteosat and indication of the vigour and extension of plat cover based on NDVI
			Food security monitoring	At global, regional, national and subnational level through the collection of market export prices, trade, stocks and demand
			GIEWS workstation	Tools that includes country cereal balance sheets, software (WINDISP) for the display and analysis of maps and satellite images
			GEOWEB	Facility that allows to access to GIEWS databases and tools over Internet
			Mailing list	Various mailing lists to disseminate special reports and alerts
			Publications and reports	Regular reports and short reports to provide timely alert
Famine Early Warning Systems Network United States Agency for	To strengthen abilities to manage risk of food insecurities through the provision of timely and	National	Alerts	Provides specific information on causes and effects of the developing crisis, which helps decision makers and planners prepare for and respond to these crises

Name and organization	Objectives	Scale	Main modules	Description
Agency for International Development < <a href="http://www.fews.net/">http://www.fews.net/</a> >	timely and analytical early warning and vulnerability information		Weather hazards	Integrates existing national weather service official medium (3–5 day), extended (6–10 day) and long-range (monthly and seasonal) forecasts and outlooks, and hydrological analyses and forecasts
			Maps, data and remote sensing	Offers real-time data on NDVI, Meteosat rainfall estimation, Water Requirement Satisfaction Index, latitudinal position of the Africa Inter-Tropical Convergence Zone (ITCZ)
			Vulnerability analysis	Based on livelihood baseline and food economy analysis
			Reports	Monthly report located in the regional centre of the system and special reports downloadable from the Internet
			Contingency and response planning	It allows warning information to be translated to action
Suremode, a surveillance system for assessing and monitoring of desertification Consejo Superior de Investigaciones Científicas, Spain, MIMAN (Dirección General de Conservación de la Naturaleza, Spain) < <a href="http://www.eeza.csic.surmode.s">http://www.eeza.csic.surmode.s</a> >	Its goal is to develop a prototype of a surveillance system to be operated at the country scale and that allows discriminating between current and relict desertification; forecasting desertification under chosen climatic and socio-economic scenarios; and monitoring land degradation status over large areas using objective and low cost methods	National Province	Observatory network	(a) Field terminals (b) Development of telemetry for data acquisition (c) Construction of data bases
			Information system	(a) Bibliometric analysis of scientific papers (b) Construction of a GIS for spatial data (c) Databases consulted and organized
			Early warning of risk	(a) Hot spots: areas where desertification is likely to occur in the present conditions (b) Trends on scenarios: creation of scenarios to forecast responses by dynamic system modelling and decision support systems (c) Forecasts changes at these hot spots in risk scenarios
			Trends in land condition	(a) Indexes and indicators (vegetation, drought, degradation) (b) Trend detection

## **V. Early warning systems for desertification: summary of trends and constraints**

13. One of the key instruments to implement the Convention is the national action programme (NAP). NAPs are based on a participatory approach involving practical steps and measures to be taken. A desertification early warning system would be an instrument and initiative to combat desertification in the framework of the NAPs. Indeed, article 10 (3) of the Convention identifies the importance of strengthening activities relating to early warning systems.

14. Under the UNCCD, several initiatives have been promoted for the development and implementation of desertification early warning systems in action programmes at national, regional and global scales. Considerable work on early warning systems for drought and desertification has been done in many countries, but still no operational systems exist to be successfully implemented in strategies, plans and programmes to combat desertification. The main objective of a desertification early warning system is to forewarn people about land degradation and its potential impacts, so that remedial measures can be taken in advance.

15. Desertification develops slowly from mismanagement of land and through the interaction of the natural ecosystem and the human social system. Its assessment and prediction depend on the availability of physical, biological, social and economic information from different sources. Desertification is difficult to predict because of the complexity of the interaction of the multiple driving forces and its long-term nature. There are still knowledge gaps and pending questions on translating broadly accepted principles of early warning into action-oriented modalities.

16. Recent reviews of the current operational status of early warning systems in the context of the UNCCD by ad hoc panels on early warning systems have revealed the major advances and constraints for each one of the four components listed in paragraph 7 and figure 1. Most reviews concluded that the existing early warning systems in the context of desertification are still deeply focused on drought and food security. Also, extensive technical improvements in the provision and accuracy of early warning systems have been observed, which have led to a better understanding of physical causes and modelling. In contrast, progress in enhancing the effective use of warning has been relatively slow.

17. Several weaknesses have been detected in areas relating to desertification assessment and monitoring, dissemination of information to end-users, institutional arrangements and coordination mechanisms, and appropriate and targeted interventions:

(a) Assessment procedures are so far largely empirical and have focused on the symptoms of desertification rather than on the underlying drivers and processes. There is lack of integration between human and climate drivers, and between spatial and temporal scales which affect the desertification phenomenon;

(b) Temporal data analysis remains scarce despite its importance in understanding the dynamics and intensity of desertification and land degradation;



- (c) There are still no commonly used, and accepted, indicators and data format system for both desertification monitoring and assessment or early warning systems;
- (d) There is no existing baseline for monitoring desertification at global level;
- (e) Data accessibility is still subject to several constraints. There is a need to use metadata for assuring data reliability and compatibility among scales of analysis;
- (f) Integration of traditional knowledge and local communities in data collection, discussion and validation of the results, and in the development of strategies for combating desertification, is still far from being achieved;
- (g) Information is not always efficiently disseminated because of the poor credibility of ill-designed warning messages and/or the failure of dissemination;
- (h) There is a lack of genuine partnership between the main stakeholders. Political and biased uses of the information by a few stakeholders have tended to render early warning systems a tool for political and selfish uses;
- (i) Coordination between early warning systems and decision makers is poor. A clear definition of the place of early warning systems in national desertification policies and programmes, and of who are the authorities responsible, is absolutely necessary for ensuring effectiveness.

18. The review panels made a clear call for expanding the scope of traditional practices of early warning systems, focused on monitoring and warning of hazards, to broader issues of risk assessment and management. They concluded that drought early warning systems should incorporate desertification monitoring into their activities and integrate systems to address drought and desertification rather than establish separate systems.

## **VI. Desertification early warning system: from research to application**

19. Each early warning system must be organized according to the nature and characteristics of the problem or concept that is the focus of attention of the system. Desertification can be expected to be a phenomenon of large areas and long time span because the related processes have very low frequencies. Desertification early warning systems must reflect the appropriate spatial and temporal scales for detecting desertification. For instance the early warning systems for prediction of famine, starvation and drought reviewed in table 1 work at the regional and national spatial scales, and on annual, seasonal and monthly temporal bases. In a desertification early warning system, the spatial and temporal scales would be different. Although a regional scale of 1° x 1° area has been proposed as the most suitable for assessment and monitoring of desertification, desertification early warning systems must be built up on a range of scales from global to local. At global scale climate characteristics, government policies and cultural traditions, including land tenure and livestock ownership, set the boundary conditions or state variables within which the desertification process operates. But at a finer scale, local level, land management, vegetation dynamics, and socio-economic factors control the mechanisms leading to desertification. Land degradation problems act also at a longer time scale than the time scales proposed for drought and famine early warning systems. Monthly, seasonal and annual scales

deal with cyclic, short-term fluctuation. Much longer scales – 20–25 years – have been proposed for vegetation analysis, needed to identify significant trends in desertification.

20. To start thinking on the design of a desertification early warning systems, three basic questions are proposed (table 2):

- (a) What contributions can be expected from a desertification early warning system?
- (b) How can a desertification early warning system fulfil these expectations?
- (c) Which updated resources are available to accomplish the expectations?

21. A desertification early warning system should be a basis for the exchange of information but also an instrument for assessing, monitoring, predicting, warning or alerting and support decisions. All these actions can be developed using tools provided by scientific research results. Past and present projects of the Environmental Programme of the European Union (EU) can contribute very much to the different actions that a desertification early warning system should undertake (table 2).

**Table 2. Proposed questions to start organizing a desertification early warning system**

<i>WHAT can be expected?</i> ACTIONS	<i>HOW to fulfil expectations?</i> INSTRUMENTS	<i>WHAT resources are available?</i> RESOURCES (EU projects)
<b>Exchange of information</b>	Clearing house mechanism	CLEMDES, DESERTSTOP, LUCINDA
<b>Assessing</b>	Environmental indicators, updated spatial evaluation of areas using GIS	AID-CCD, LADAMER, D-SURVEY
<b>Monitoring</b>	(a) Environmental indicators (b) Use of thresholds	AID-CCD, DESERTLINKS, LADAMER D-SURVEY, INDEX
<b>Predicting</b>	Modelling of scenarios, hazard analysis	GEORANGE, D-SURVEY
<b>Warning</b>	Control of thresholds, risk analysis	D-SURVEY
<b>Support decisions</b>	(a) Use of decision support systems (b) Mitigation and restoration strategies	MEDRAP, REACTION, SCAPE, MEDACTION, RECONDES D-SURVEY

22. The already obtained and expected outputs of all of the research projects founded within the 5<sup>th</sup> and 6<sup>th</sup> Framework Programme of the EU can contribute in different ways to potential modules of a desertification early warning systems, coupled, for example, as expressed in table 3.

**Table 3. Comparison of outputs of European Union funded project with actions of a desertification early warning system**

<b>EC Project</b>	<b>Expected outputs of the project</b>	<b>Possible contribution to desertification early warning system<sup>a</sup></b>
AID-CCD < <a href="http://nrd.uniss.it/sections/aid-ccd/index.htm">http://nrd.uniss.it/sections/aid-ccd/index.htm</a> >	(a) Exchange of information on desertification indicators (b) Establishment of information circulation systems	(a) Exchange of information (b) Monitoring
DESERTLINKS < <a href="http://www.kcl.ac.uk/projects/desertlinks/">http://www.kcl.ac.uk/projects/desertlinks/</a> >	Desertification indicator system tested by stakeholders	(a) Monitoring (b) Assessing (c) Warning
MEDACTION < <a href="http://www.icis.unimaas.nl/medaction/">http://www.icis.unimaas.nl/medaction/</a> >	(a) Development of land-use scenarios (b) Effects of past policies (d) Decision support systems	(a) Predicting (b) Support decisions
CLEMDES < <a href="http://www.clemdes.org/">http://www.clemdes.org/</a> >	Establishment of a clearing house mechanism on desertification	Exchange of information
GEORANGE < <a href="http://www.georange.org/georange/">http://www.georange.org/georange/</a> >	(a) Integration of processed data sets and spatial information for non-experts (Internet and intranet based) (b) Implementation of techniques and tools for evaluating current rangeland conditions (c) Define scenarios based on multifunctional use of rangelands	(a) Exchange of information (b) Assessing (c) Predicting
LADAMER < <a href="http://www.ladamer.org/ladamer/">http://www.ladamer.org/ladamer/</a> >	(a) Assembled database on land degradation from various European and international institutions (b) Regional assessment of land degradation status (from remote sensing) (c) Coupling of a model with data derived from remote sensing (d) Regional change maps of vegetation density and land use	(a) Exchange of information (b) Assessing (c) Monitoring
MEDRAP <a href="http://nrd.uniss.it/medrap/index.htm">http://nrd.uniss.it/medrap/index.htm</a>	Guidelines and strategies for the elaboration of the regional action programme to combat desertification	(a) Exchange of information (b) Support decisions
REACTION < <a href="http://www.gva.es/ceam/reaction/Project.htm">http://www.gva.es/ceam/reaction/Project.htm</a> >	(a) Exchange of information on land restoration between stakeholders (b) Database on land restoration (c) Guidelines for land restoration	(a) Exchange of information (b) Support decisions
SCAPE < <a href="http://www.scape.org/">http://www.scape.org/</a> >	Guidelines, recommendations and strategies to support sustainable soil conservation	(a) Exchange of information (b) Support decisions
DSURVEY < <a href="http://www.desurvey.net/">http://www.desurvey.net/</a> >	A surveillance prototype for periodic assessments of desertification status, for forecasting possible trajectories (early warning), and for evaluating the performance of mitigation programmes	(a) Assessing (b) Predicting (c) Warning (d) Support decisions
INDEX < <a href="http://www.soil-index.com">http://www.soil-index.com</a> >	Soil-quality-based indicators for early and rapid identification of soil deterioration and for monitoring the efficacy and suitability of remediation methods.	Monitoring

EC Project	Expected outputs of the project	Possible contribution to desertification early warning system <sup>a</sup>
RECONDES < <a href="http://www.port.ac.uk/research/recondes/">http://www.port.ac.uk/research/recondes/</a> >	Practical guidelines on the conditions for use of vegetation in areas vulnerable to desertification, taking into account spatial variability in geomorphological and human-driven processes	Support decisions
LUCINDA	(a) Provide a concise and comprehensive information pack containing guidelines for sustainable land management in desertification-affected areas (b) Make this information available to regional and local authorities	Exchange of information
DESERSTSTOP	Platform to bring together leading scientists working in the fields of remote sensing and geoinformatics with a focus on desertification and land degradation with potential users.	Exchange of information

<sup>a</sup> In relation to the actions included in a desertification early warning systems of table 2

## VII. Conclusions and recommendations

23. The development and use of early warning systems have been encouraged as promising tools to prevent and mitigate desertification. Nevertheless, there are no desertification early warning systems fully implemented in the action-oriented instrument of the UNCCD. Desertification is a complex phenomenon, triggered by low-frequency processes whose detection requires a larger spatial and temporal scale than those used in conventional approaches to drought and food security early warning. In order to develop efficient desertification early warning systems several actions are needed to overcome limitations:

(a) Assessment of desertification must be based on underlying driving forces and processes rather than symptoms;

(b) A long-term monitoring network must be maintained, and new facilities established, for providing data to detect changes in desertification trends and to establish reference values of state variables;

(c) Information transfer mechanisms and procedures must be improved for reaching the target population in an efficient way and on time;

(d) Closer coordination is needed between warning and decision-making elements;

24. Desertification early warning systems should be built upon the four elements identified in people-centred warning systems: risk knowledge, monitoring and warning services, dissemination and communication, and response capability.

25. The development and implementation of desertification early warning systems may take advantage of existing observation networks, warning centres, assessment, monitoring and modelling capacities, telecommunication networks, and preparedness and response capacities.

26. There is need to strengthen the links among the future work on benchmarks and indicators, desertification assessment and monitoring, and early warning systems that should be carried out by an ad hoc working group under the auspices of the Convention.

27. The implementation of pilot studies in the development and effective application of desertification early warning systems and the report of their results to the Committee on Science and Technology and the Conference of the Parties should be encouraged.

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