Musson, R. M. W., Grünthal, G., Stucchi, M. (1995): Comments on 'The 17 August 1991 Honeydew earthquake: a case for revising the modified mercalli scale in sparsley populated areas' by Dengler and McPherson. - *Bulletin of the Seismological Society of America*, *85*, 4, pp. 1266—1267.

Bulletin of the Seismological Society of America, Vol. 85, No. 4, pp. 1266–1267, August 1995

Comments and Replies

Comment on "The 17 August 1991 Honeydew Earthquake: a Case for Revising the Modified Mercalli Scale in Sparsely Populated Areas" by Dengler and McPherson

by R. M. W. Musson, G. Grunthal, and M. Stucchi

In a study of the 17 August 1991 Honeydew earthquake, north coast California, the authors Dengler and McPherson found difficulty in applying the Modified Mercalli scale in its version of 1931, and made some alterations, which are presented in their article (Dengler and McPherson, 1993). We believe there are some problems with the approach they adopt, and also that the questions raised by the revision of macroseismic scales require wider discussion.

Mercalli published his first intensity scale in 1883 (Mercalli, 1883)—a six-degree scale that bears little resemblance to any scale used today. Mercalli's second scale (Mercalli, 1897, 1902) is a modified Rossi–Forel scale with ten degrees of intensity. The scale published by Wood and Neumann (1931) is a translation of the scale of Sieberg (1912, 1923) and should not really have had Mercalli's name attached to it.

The use of the phrases "Mercalli scale" and "Modified Mercalli scale" is becoming hopelessly confused. So far as we are aware the following variants are in print: Wood and Neumann (1931, two versions), Richter (1958), Eiby (1965), Brazee (1978), Principia (1982), NZSEE (1991), and now Dengler and McPherson (1993)—eight different scales, all claiming to be "Modified Mercalli," all quite different and none resembling the actual work of Mercalli. This confusion needs to be ended. It would be greatly appreciated if authors would take the credit for their own work, and the title "Dengler and McPherson scale" would be an improvement on "Rural Mercalli scale." The difficulty can be illustrated by the remark made by the authors in their introduction that they found the "ground motion was stronger than the VII estimated by the National Earthquake Information Service . . . and that intensity estimates based on the Modified Mercalli Intensity Scale (Wood and Neumann, 1931) underestimated the true strength of shaking." But estimates made using the Modified Mercalli scale *are* the Modified Mercalli intensities. The text suggests that the authors have their own conception of the "ideal" intensity 7, which they then attempt to define. It remains to be established that this is consistent with figures derived by other workers who also claim "Mercalli" intensities. If the figures are not consistent (as one supposes they are not, at least with respect to the NEIS values), then what value has the name of Mercalli?

There are considerable problems with the scale proposed by Dengler and McPherson: this scale may have suited their purposes in studying the 1991 Honeydew earthquake, but would lead to errors if applied generally. The main issue is that of earthquake effects on nature. In rural areas, there is certainly a problem in assessing intensity owing to the absence of human structures to observe. Unfortunately, there is really no good solution to this problem, since it can be demonstrated that such effects as spring turbidity, landslides, rockfalls, and so on are heavily dependent on factors other than the strength of ground shaking—for example, hydrological conditions (Vogt *et al.,* 1994). These other factors are so important that effects on nature cannot be used *reliably* as diagnostics of earthquake intensity—they are observed over too wide a range of intensity degrees. They can be used in a confirmatory way given other evidence, as long as the investigator is careful. Obviously this implies that intensity cannot be assessed in a place that is completely uninhabited. This is true, and this limitation has to be accepted, rather than tackled in an inadequate way.

Other problems are more minor—it is dangerous to include such absolutes as "nothing is knocked over or falls from shelves" (intensity 4). Common sense shows that objects sometimes fall from shelves without any earthquake, and therefore the occurrence of single or few instances of this effect cannot be used to eliminate intensity 4 (or 3, for that matter). We find it hard to understand the diagnostic for intensity 9 "similar effects to VIII above but more widespread" which implies that when intensity 8 is widespread it somehow becomes intensity 9. The quoting of average (mean) intensity as is shown in Dengler and McPherson's Figure 2 was condemned over 30 yr ago by Richter (1958) and nothing has happened since to suggest that this practice is acceptable.

We sympathize with the problem of dealing with earthquake effects to wooden frame structures, which often demonstrate very high levels of resistance to earthquake shaking. We believe the solution is not to make a special scale, but to apply what we term a "vulnerability class table," in which different building types of any form of construction can be compared in terms of their ability to withstand earthquakes, and which can be applied to any situation, taking into ac-

count building condition, in a flexible and robust manner. Such an approach is incorporated in the new European Macroseismic Scale (EMS), now published as a preliminary version (Grunthal, 1993). Other innovations introduced in the EMS, briefly, are as follows: a guide to the use of the intensity scale, a classification of damage differentiated into structural and nonstructural effects and into masonry and reinforced concrete buildings (aided by graphical illustrations), a collection of illustrative photographs, special sections on engineered constructions and effects on nature, and two worked examples of intensity assignment.

Acknowledgments

The preparation of this article was supported by the Natural Environment Research Council and is published with the permission of the Director of the British Geological Survey (NERC).

References

Brazee, R. J. (1978). Reevaluation of Modified Mercalli intensity scale for earthquakes using distance as determinant, NOAA Tech. Mem EDS NGSDC-4.

Dengler, L. and R. McPherson (1993). The 17 August 1991 Honeydew earthquake, north coast California: a case for revising the Modified Mercalli scale in sparsely populated areas, *Bull. Seism. Soc. Am.* **83,** 1081–1094.

Eiby, G. A. (1965). The Modified Mercalli scale of earthquake intensity and its use in New Zealand, *New Zealand J. Geol. Geophys.* **9,** 122–129.

Grunthal, G., Editor (1993). European Macroseismic Scale 1992 (updated MSK Scale), in *Cahiers du Centre Européen de Géodynamique et de Séismologie no 6,* Luxembourg.

Mercalli, G. (1883). *Vulcani e Fenomeni Vulcanici in Italia,* 374 pp.

Mercalli, G. (1897). I terremati della Liguria e del Piemonte, Naples.

Mercalli, G., (1902). Sulle modificazioni proposte alla scale sismica de Rossi-Forel, *Boll. Soc. Sism. Ital.* **8,** 184–191.

NZSEE (1991). A revision of the Modified Mercalli seismic intensity scale: report of a study group of the New Zealand Society for Earthquake Engineering, *Bull. New Zealand Nat. Soc. Earthquake Eng.* **25,** 345–357.

Principia Mechanica Ltd (1982). *British Earthquakes,* PML, London.

Richter, C. F. (1958). *Elementary Seismology,* W. H. Freeman, San Francisco.

Sieberg, A. (1912). Über die makroseismische Bestimmung der Erdbebenstärke, *Gerl. Beitr. Geophys.* **11,** 227–239.

Sieberg, A. (1923). Erdbebenkunde, Fischer, Jena.

Vogt, J., R. M. W. Musson, and M. Stucchi (1994). Seismological and hydrological criteria for the new European macroseismic scale, *Nat. Hazards* (in press).

Wood, H. O. and F. Neumann (1931). Modified Mercalli intensity scale of 1931, *Bull. Seism. Soc. Am.* **21,** 277–283.

British Geological Survey
Edinburgh EH9 3LA, United Kingdom
(R.M.W.M.)

GeoForschungszentrum Potsdam
D-14473 Potsdam, Germany
(G.G.)

Consiglio Nazionale delle Richerche Istituto di Ricerca sul Rischio Sismico
I-30131 Milano, Italy
(M.S.)

Manuscript received 20 January 1994.