ERRATA

Corrections and Comments to
‘A Markov Model for Aftershock Occurrence’

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Dr. KEIITI AKI has drawn my attention to an error in the discussion in my note ‘A Markov model for aftershock occurrence’ [1]²⁾. In § 5 of that note, where transformations of the type

$$E = g(\eta)$$

are discussed for the energy variable E in the basic model described in the preceding paragraph, it is stated (p. 40 line 3 from top) that under such a transformation the new form of the frequency-magnitude law can be written down directly from the equation

$$\tilde{\mathcal{M}}(\eta) = \mathcal{M}[g(\eta)]$$

(here and in what follows we use the notation of the earlier paper without comment). This is not true, as it is the distribution of the energy variable, given by the function $\theta(E)$, which transforms in this way (so that $\tilde{\theta}(\eta) = \theta[g(\eta)]$), whereas the new frequency magnitude law must be calculated by substituting this expression for $\tilde{\theta}(\eta)$ in equation (13) (p. 36).

This error affects in particular formula (23a) on p. 41, where the new frequency-magnitude law is calculated under the transformation $E = \eta^\beta$. Here we have $\tilde{\theta}(\eta) = -\beta \log \eta$, and after substituting this expression in (13) we find

$$\tilde{\mathcal{M}}(\eta) = -\beta \log \eta + O(1) \quad (\eta \rightarrow 0)$$

Thus the asserted form still gives the leading term, but correction factors are needed near $\eta = 1$. The general conclusions are not affected by the error.

Dr. AKI has also pointed out that this model forms a natural extension of the model considered in his 1956 paper [2], in that (referring to the set up described in § 4 of my paper) after a shock the parameter $\lambda(E)$ describing the waiting time to the next shock is reduced on the average by a constant proportion $1/1 + \alpha$ of its value before the shock. This assumption (without the averaging) is the essential characteristic of Dr. AKI’s model, where the parameter after the n ’th aftershock is assumed to have the form $k e^{-kn}$.

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²⁾ Numbers in brackets refer to References, page 204.

Two further points are of some interest. Firstly, at the time of writing the original article, I was not aware of any transformation of the energy variable that would bring the frequency-magnitude law into the Pareto form observed in practice. However, it turns out that this can be accomplished, for example by the transformation

$$E = e^{-D\eta^{-v}}$$

where D and v are positive constants. In this case we find

$$\tilde{\theta}(\eta) = D \eta^{-v}$$

and substitution of this expression into (13) leads to a rather complicated integral, the leading term of which can be shown to be proportional to $\eta^{-v/1+v}$, the remaining terms again forming a contribution of $O(1)$ as $\eta \rightarrow 0$.

Secondly, a fundamental point of difference with observed aftershock sequences is raised by Professor LOMNITZ' recent discovery [3] of 'magnitude stability', according to which only the frequency of the shocks decreases along the sequence, being there no apparent tendency for the later shocks to be of smaller magnitude. A similar effect has been observed in a recent New Zealand aftershock sequence [4]. It is hard to see how such a phenomenon can be reconciled to any model based on the idea of an energy 'reservoir' which is gradually depleted by the energies released in successive aftershocks. Certainly, it is a characteristic feature of the Markov model under discussion that the mean energy level of the reservoir, and hence also the mean energy of the aftershocks themselves, decrease steadily along the sequence; this feature will not be affected by any monotonic transformation of the type described earlier.

In conclusion, I should like to take this opportunity of thanking Dr. AKI for his interest in this work, and of correcting some minor errors which slipped into the original paper.

p. 32 In equations (1), (2) and (3) for '=' read ' $\propto$ '

The first equation in line 3 from bottom should read

$$\log A = a + \frac{11.8 b}{1.5}.$$

p. 34 Equation (7): omit '- '.

p. 36 Equation (11): for $dF_{n-1}(E)$ read $dF_{n-1}(H)$.

Equation (13): for $P(1, 1-E)$ read $F(1, 1-E)$.

p. 41 Third equation from bottom: omit the first '- '.

The word 'occurrence' is spelt wrongly in the title of the article.

REFERENCES

- [1] Pageoph 64 (1966/II), 31-42.
- [2] K. AKI, *Some problems in statistical seismology*, Zisin 8 (1956), 205-228.
- [3] C. A. LOMNITZ, *Magnitude stability in earthquake sequences*, Bull. Seis. Soc. Amer. 56, 247-249.
- [4] R. M. HAMILTON, *The Fiordland earthquake sequence of 1960 and seismic velocities beneath New Zealand*, N. Z. J. Geol. and Geophysics 9 (3), 224-238.

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