

## HOW THE RIO SCALE SHOULD BE IMPROVED

Iván Almár

Konkoly Observatory, Budapest, Hungary

almar@konkoly.hu\*

### ABSTRACT

A paper was presented at the 51st International Astronautical Congress in Rio de Janeiro to introduce a numerical method of characterizing the potential significance of any announcement of discovery of extraterrestrial intelligence. The wide-ranging discussion following this presentation raised challenging ideas for the improvement of the so-called Rio Scale. The present paper intends to summarize the discussion and the authors' reflections to some comments received from members of the SETI community. Some improvements to the first version of the Rio Scale are suggested in order to make the method more accurate and usable.

### INTRODUCTION

A paper<sup>1</sup> was presented at the 51st International Astronautical Congress in Rio de Janeiro by Jill Tarter and myself in order to introduce a numerical method for ranking the potential significance of any announcement of the discovery of extraterrestrial intelligence or traces of an extraterrestrial civilization. The "Rio scale" was defined as  $RS = Q \times \delta$  where  $Q$ , as the estimated level of consequences, was the sum of three parameters (the class of phenomenon, the discovery type and the distance respectively) and  $\delta$  represented the assessed credibility of a claimed discovery. The result – in the form of a linear scale between 0 and 15 – was named "The Rio scale" (with reference to an analogy with the so called "Torino scale" characterizing an impending asteroid impact) and was intended to be used by the scientific community and the media to evaluate the consequences of an announcement of a putative ETI discovery.

The paper triggered a vigorous discussion in Rio de Janeiro during a meeting of the Post-Detection

Science and Technology Subcommittee of the IAA SETI Committee. According to its chairman, Dr. Ray Norris, there was an enthusiastic consensus that an approach along these lines was an excellent idea, but also it was heavily debated how the various factors should be ranked. Since I could not be present at the meeting, he has sent me a short summary of the suggestions<sup>2</sup>.

Since I had the impression that other members of the SETI community might also have differing views on the subject, in November 2000 I sent letters to some 35 colleagues asking them for their co-operation and comments. All personal communications received in 2000 or early 2001 were taken into account in the present paper. The author would like to thank all these colleagues who took the trouble to draft their remarks; they are discussed one by one in the following sections. Then a somewhat modified version of the Rio scale is presented. Finally suggestions are made concerning mechanisms to gain acceptance of the Rio scale.

### REMARKS OF PRINCIPLE

---

\* Copyright © 2001 by the International Academy of Astronautics. All rights reserved.

In the present section fundamentally important comments and remarks are discussed. Many colleagues expressed the view that the topic is important and timely. “Your Rio scale idea is excellent and useful, and well conceived.” (A. Tough<sup>2</sup>) “It’s a great paper – the tool you are proposing cannot come a moment too soon.” (C. Oliver<sup>2</sup>) “I think I share with most of our colleagues a belief that the Rio Scale would be a beneficial standard for all concerned.” (P. Shuch<sup>2</sup>) “I found it an excellent idea to have a similar scale to the Torino scale for the SETI.” (V. Pletser<sup>2</sup>).

One very different view was expressed. P. Schenkel wrote in his letter<sup>2</sup>: “Why do two distinguished astronomers address a matter which concerns mainly social sciences or better, which should be a primary concern of social sciences?” and “Can a numerical method really assess the significance and the consequences of different scenarios of Contact with ETI?” Answering these important questions I would like to emphasize that the announcements of putative discoveries we are discussing as well as the circumstances we are ranking are, or will be, most likely connected with physics and astronomy – not social sciences. Furthermore the topic we are trying to cover is not necessarily *contact with ETI* but the possible discovery of messages, beacons, traces etc. of ETI – overwhelmingly expected to occur during *astronomical observations*.

It is not surprising that social scientists give a somewhat one-sided scenario of how the discovery of ETI might happen: e.g. A. Harrison in his excellent book “*After Contact*”<sup>3</sup> states definitely several times: “Although we could encounter a live ET or stumble across an alien probe or artifact, the most likely scenario is that first contact will consist of our detecting extraterrestrial radio activity.” (p. 199) and “Contact, if it occurs, is likely to occur through the interception of microwave radio waves.” (p.

249). This is, of course, *one* of the possible scenarios only, represented in some of the central cases of Fig. 1 for the variable Q. I am convinced, however, that an *a priori* guess of the probabilities belonging to the 120 cases of Fig. 1 is at present not feasible.

P. Schenkel in his letter raises several other principle objections as well: “Why saying that discovery of ETI is a ‘low-probability event’? We don’t know the probability of discovery.” Yes, indeed, we cannot assign any kind of probability numbers to the different classes and types of ETI discovery. But within a reasonable time interval, like a decade, an ETI discovery is certainly a low probability event as compared to other events like the discovery of a new type of variable star or a new kind of microbe. In that sense we can accept that the discovery of ETI might be considered a “low probability – high consequence” event.

Finally P. Schenkel is strictly against using a method designed for *potentially highly catastrophic events* (like impacts – see the Torino scale) for an event of such enormous significance for our civilization as contact. The general public – he writes – will necessarily associate Contact with the “danger aspect” of a NEO impact!

It is certainly true that scales, like the Torino scale, are usually connected to threatening phenomena. There is a similar (simple) scale for the effects of a solar burst as well<sup>4</sup>. Quite recently a 0 to 100 linear scale composed from two factors (strangeness and credibility) was suggested to help to gauge the potential significance of any UFO (or UAP – unidentified aerial phenomena) report<sup>5</sup>. What is, however, common in all these efforts to make a numerical ranking of the importance of something unusual is not their “danger aspect”, but the level of consequences depending on the actual character of the circumstances. Nobody is able to estimate all such consequences in advance (sometimes not even whether they will be positive or negative for us personally, for a nation or for humankind), but

the bottom line in all cases is that based on the circumstances of the discovery and the credibility of the discoverer the magnitude of its importance can be estimated. The Rio scale is nothing but an experiment along these lines.

There was another related point, seemingly technical, which was raised during the Subcommittee meeting: “The ranking should be based on objectively measurable observables (e.g. characteristics of the signal or status of the observer) rather than inferred quantities. Flux density should be a factor.” I must respectfully disagree with this opinion. Such a modification of the Rio scale, if feasible, would narrow down its generality considerably. Obviously the “objectively measurable observables”, like flux density, wavelength, polarity or other parameters of an electromagnetic signal would not be suited for traces of astroengineering activity or SETA results in general. Even in the case of electromagnetic messages or beacons I don’t believe that flux density is a crucial factor in the evaluation of the significance of a discovery: the character of the signal (Earth-oriented or not, steady or transient) is much more important from this standpoint. Any attempt to find objectively measurable observables is welcome, but it should be applicable to all classes of phenomena and to all types of discoveries – otherwise the ranking system will be inconsistent and incomplete.

#### TECHNICAL REMARKS

Several technical questions were raised during the Subcommittee’s discussion and in the letters as well. There was a strong view, shared by C. Oliver and other members of the Subcommittee, that the final Rio scale (RS) value should be an integer between 1 and 10, which is what people are used to, rather than 1 to 15. This would be nearer to the traditional ranking (“How would you rate that on a scale of 1 to 10?”). Accepting this suggestion the new version of the Rio scale, given in the next section, is modified accordingly.

The second technical modification proposed by the Subcommittee was the use of logarithmic rather than linear scales. In particular they suggested applying a log scale for the believability of a detection (e.g.  $10^{-6}$  to 1), taking into account its probability. This problem is related to a previously discussed one (“let us use objectively observable variables”) and ultimately to the basic philosophy of the Rio scale experiment. It is not feasible to determine the probability of any kind of detection in advance, the present Rio scale is based therefore on broad categories and a very rough distance scale (which might be conceived as logarithmic as well). The  $\delta$  or believability factor (“the assessed credibility of the claim”) is estimated subjectively. Anybody who can define an objectively measurable parameter of credibility is welcome.

V. Pletser has suggested a fourth index to assess “the likelihood of physical contact” within a reasonable future. As he recognized, however, this fourth scale would be closely related to other indices like distance or the class of the phenomenon.

The Subcommittee also proposed that “different factors need to be combined with different weights” and that “for all axes it will be important to have a median score which means ‘don’t know’.” These are certainly interesting possibilities to make the Rio scale better, but also more complicated. For the sake of simplicity I would rather retain the present form until an essentially improved version emerges. (The ‘don’t know’ case can be represented at present by giving both a minimum and a maximum RS value. The range on these values will indicate the range of our ignorance as well.)

A. Tough suggested using the word *importance* rather than *significance* because most social scientists would think of statistical significance when they see the word. I accept his remark with thanks. K. Cullers has asked whether “message” in Table 1. means that the signal has anti-cryptographic information? The answer is

probably yes. More than one colleague stressed that “anything in our Solar System – intentional or not – would have high significance.” (V. Pletser, S. Shostak) Although the distance index gives a higher weight to discoveries within our Solar System, nevertheless I accept that a direct, physical contact with extraterrestrials within the Solar System should be rated as an extremely important class of phenomenon. The relevant scale has been modified accordingly.

I don’t agree, however, that *any kind* of discovery within our neighborhood should receive an outstanding Q value (as compared e.g. to Earth-specific messages from distant sources). D.L. Holmes wrote on encountering artifacts in the Solar System<sup>6</sup>: “The most likely kind of artifact to be found of any past or present society is a piece of trash: a potsherd or a plastic bag. Alien trash could range from dust-sized particles to derelict spaceships.” In such a case I think that the consequences would be moderately important only. J. Tarter<sup>2</sup> wrote however, that “If the trash were a *confirmed* ETI relict, I think the consequences would be important. They were here at one time, they might still be, or might come again.”

One final remark to the technical questions. Nobody has suggested a different discovery scenario that does not fit into the 120 cases of Fig. 1 or Table 1. This fact can be considered as an acknowledgment that the Rio scale would work in real situations because it is as near to completeness as feasible at present.

A MODIFIED VERSION OF THE  
RIO SCALE

Taking into account some of the suggestions outlined in the previous sections the modified version of the Rio scale would be as follows. The level of *importance* of any putative discovery of an ETI would be again

$$RS = Q \times \delta,$$

i.e. the level of the probable consequences multiplied by the assessed credibility of the claim. The one-dimensional variable Q is defined as the sum of three parameters given in Table 1.

Figure 1 (at the end of the paper) illustrates in a somewhat modified way the position of the 120 possible cases in the three-dimensional Q space. The weight assigned to each of the categories corresponds to the level of possible consequences (social, intellectual, scientific, political and religious). The variable Q can take a value from 3 to 15.

Class of phenomenon	
6	Earth-specific message or direct (physical) encounter
5	Omnidirectional message with anti-cryptographic information
4	Earth-specific beacon to draw attention of our civilization
3	Omnidirectional beacon to draw attention of any civilization
2	Leakage radiation, clearly of ETI origin, but no interpretation possible
1	Traces of astroengineering activity either in the Solar System or at interstellar distances. Any indication of ET technological activity by an extant or extinct civilization.

Discovery type	
5	Result of SETI/SETA activity: a steady phenomenon, verifiable by repeated observations/investigations.
4	Result of any other kind of observation: a steady phenomenon, verifiable by repeated observations/investigations.
3	Result of SETI/SETA activity: a transient phenomenon, verified, but never experienced again.
2	Result of any other kind of observation: a transient phenomenon, reliable, but never repeated.
1	Evaluation of archival data: <i>a posteriori</i> discovery of a phenomenon in a data base without the possibility of verification.

Distance	
4	Within our Solar System
3	Within a distance which allows a communication

	at light speed within a human lifetime.
2	Within our Galaxy
1	Extragalactic

TABLE 1. Parameters of Q

As in our previous paper<sup>1</sup> a factor  $\delta$  should be introduced to represent the estimated credibility of the claimed discovery. Its value, however, should not be between 0 and 1, but only one of the following 5 numbers:

$$0, 1/6, 2/6, 3/6, 4/6$$

in order of growing credibility. Thus the final RS value will be between 0 and 10.

0	obviously fake or fraudulent
1/6	very uncertain, but worthy of verification efforts
2/6	possible, but should be verified before taken seriously
3/6	very probable with verification already carried out
4/6	absolutely reliable, without any doubt

TABLE 2. Delta factors

We define RS as the nearest integer to the  $Q \times \delta$  value. Table 3 (corresponding to Table 3 in paper<sup>1</sup>) is giving the RS values from 0 to 10 as the “level of importance”:

0	none
1	insignificant
2	low
3	minor
4	moderate
5	intermediate
6	noteworthy
7	high
8	far-reaching
9	outstanding
10	extraordinary

TABLE 3. Level of importance (RS)

Finally, two remarks to the use of the Rio scale. It is certainly not always feasible to select just one RS value after the announcement of a discovery. The ambiguity of the circumstances (e.g. the distance is not known) can lead to a range of RS values representing the range of uncertainty. Such a situation, however, does not decrease the usefulness of the scale.

On the other hand, RS values can and should change with time – like the Torino scale does. If the verification procedure leads to new positive or negative results than the RS value should change accordingly. The requirement of a periodic adjustment of the RS value is reasonable.

Several colleagues asked for some examples, even in retrospect. The EQ Peg hoax in October 1998 might be such a case. The circumstances of the announcement of the “discovery” made by a British amateur astronomer indicated clearly enough that the discovery is a hoax, therefore  $\delta = 0$  and  $RS = 0$  (independently of other factors). The well-known WOW signal observed in 1977 by a SETI group at the Ohio State University Radio Observatory is a different case. The class of phenomenon is unknown, it might have been an Earth-specific or an omnidirectional beacon (4 or 5). The discovery type is 3 (transient), the distance is unknown, probably 1-3. Therefore Q is between 8 and 11. If  $\delta = 1/6$  then the resulting RS would be between 1 and 2 meaning an insignificant or low level of importance. Finally we can address the hypothetical case in C. Sagan’s famous novel, *Contact*. It would be clearly an Earth-specific message (6) discovered by a SETI team (5) from a known distance of 26 lys (3). The resulting Q would be 14. If  $\delta = 4/6$  (absolutely certain) then we have  $RS = 9$ , which means outstanding importance.

### HOW TO CONTINUE?

There is a general consensus within the SETI community that after a SETI discovery announcement the media will play a very important role. As A. Harrison<sup>3</sup> writes “Thus,

most people's impressions will be based less on the evidence than on journalists' and newscasters' interpretations of the evidence, interpretations that may not square with the basic facts." (p. 199) or "Our impressions and reactions will thus depend, in large part, on how word of the contact is distributed to the world at large" adding that "the accurate and responsible dissemination of the news can minimize rumor, confusion and disbelief" (p. 206).

The Rio scale is clearly intended to help in this respect. The important question is what to do next? The Subcommittee was on the opinion<sup>2</sup> that "while there is broad and enthusiastic support on the proposal, the details probably need further debate and discussion before a 'Rio scale' would be widely accepted in the SETI community. After reaching consensus we need to get formal recognition by the IAA/IAU/whatever."

C. Oliver in her letter<sup>2</sup> added several interesting, detailed suggestions how to promote the popularization of the Rio scale. When the Rio scale is ready, there should be a press announcement or press conference. Its presence on all professional SETI web sites is a necessity – perhaps with a special "Rio scale logo" which can be used later by the media. A feature style piece should be written for the common (or individual) site about the Rio scale for a wide public audience. It should be also included in the SETI literature, presented at IAU Bioastronomy conferences and at press briefings on international astronomical congresses as part of the media and public outreach. A media or journalist person in the Post Detection Subcommittee could help scientists as an adviser to provide in time the public with necessary information.

According to R. Binzel<sup>7,8</sup>, the author of the Torino scale, a similar slow procedure characterized the entry of his scale as well. "My own estimate is" – he wrote – "that this is a two years learning curve." By 2000, reports of the alleged impact of the 2000SG344 asteroid, as well

as the relevant IAU statement, were making use of the Torino scale.

Who should be authorized to make the ranking after such an announcement? My opinion is that the IAA SETI Working Group has the necessary authority, experience and international view to select immediately the proper group of experts for such an assessment. J. Tarter's view is that as a first approximation, the former Post-Detection subcommittee should be reconstituted as a Task Force whose charter and responsibilities should be reviewed every 3 years.

Using the web as a communication tool the ranking could be accomplished in a relatively short time. In a rather fortunate case the Rio scale value might be determined quickly by this group of experts, the result explained immediately to the general public through the media in order to avoid sensationalistic reports giving rise to confusion and hysteria.

## CONCLUSION

The original Rio scale proposal<sup>1</sup> had several shortcomings, but triggered a significant discussion. The present paper is an attempt to improve some of the insufficiencies as a step towards the general acceptance of a modified Rio scale by the SETI community. Our aim, the consensus, has not yet been achieved, but we still hope "that this Rio scale will be used by the SETI community and explained also to the general public and to the media to prepare them in case of a discovery" (V. Pletser<sup>2</sup>)

## ACKNOWLEDGMENT

The author wishes to express his thanks to Jill Tarter for examining the manuscript and making the most helpful suggestions.

## REFERENCES

1. Almár, I. and Tarter, J. (2000). "The Discovery of ETI as a High-Consequence, Low-Probability Event", paper presented at 51<sup>st</sup> International Astronautical Congress, Rio de Janeiro, Brazil
2. Personal communication, 2001
3. A. Harrison (1997). *After Contact, The Human Response to Extraterrestrial Life*, Perseus Press.
4. Space News 22.11.1999; EOS 18.07.2000
5. The UFO Report vol.1, No.8, December 2000
6. Holmes D.L.(1991). "Archaeology in Space: Encountering Alien Trash and Other Remains" *Bioastronomy, The Search for Extraterrestrial Life* ed.: J. Heidmann, M. Klein, Springer, pp. 227-232
7. NEO News 11/3/00
8. "Assessing the Hazard: The Development of the Torino Scale" *The Planetary Report* Vol. XIX, No. 6. pp. 6-10, 1999

Figure 1. To any announcement of the discovery of an ETI or of traces of an extraterrestrial civilization a Q value is calculated as the estimated level of consequences: it is the sum of three parameters representing the class of phenomenon (1-6), the discovery type (1-5) and the distance (1-4) respectively. The larger the Q values the darker the dots are – corresponding to more important consequences.

