OPINION

Challenges When Establishing a Seismic Network

The number of seismic stations worldwide has increased enormously over the past decades and continues to rise as new and denser networks are installed. The increase in station numbers has gone in parallel with instrumental developments, so that today broadband seismometers and high dynamic range digitizers are the standard for most applications. While the decision to acquire high-spec instruments may appear obvious, there are other requirements for the successful and sustainable operation of a seismic network. Over the years we have seen good and bad examples of seismic networks, and we believe it is time to reflect on our experience and address some issues not normally covered in textbooks. This will not be a name and shame exercise. We will also avoid a distinction between developed and developing countries because the issues are similar, although possibly more pronounced in the latter where it is more likely that a completely new network will be established.

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We have over the years contributed to workshops and training courses, mostly on the operation of seismic networks and processing of earthquake data, and as authors of the SEISAN analysis software we have provided a substantial amount of user support. We have thus had plenty of communication with network operators and people working in data processing around the world, mostly in developing countries. From places where it seems that insufficient training was received we frequently get questions about topics such as the correction for instrument response and general earthquake processing (phase picking, location, magnitude). We have received reports from network operators who were unable to do basic things with a fully installed commercial system. We have also gone to places and found that a seismic network was provided without adequate tools to transfer data from field stations or process the data. However, we have also seen good examples. In one of the bigger projects we were involved with for a decade, technical developments, science, formal education, workshops and training were combined. The most positive outcome expressed by an external evaluation at the end of the project was the successful knowledge transfer.

While seismologists may generally regard the operation of seismic networks and data processing as a special art, it's good to remain aware of the various reasons for seismic monitoring, which vary from the ability to quickly respond to damaging earthquakes to purely scientific usage of the data. The beauty of modern instrumentation is that it can be used for various applications. However, the number of networks predominantly used for routine operations may be increasing. The reality is that most seismic equipment is sold by manufacturers looking first of all after their business interests, which of course should include provision of good products and customer support.

We will now give a brief overview of how we believe a seismic network should be established, before going through some examples that show what can go wrong. We assume that little knowledge and experience are present at the start. A project would normally start with a clear definition of the purpose and objectives of the network, who is initiating and paying for the network, and who will be responsible for its establishment and operation. One should start with either training or hiring people. Ideally, a network should be started with a pilot project and only a few stations, although often there may be funding and pressure to build a complete system from scratch.

A pilot project will provide crucial experience for the next phase of planning the network. These plans must cover the equipment to be bought and the staff that will be required to run the network and process the data. At this stage, one should be aware of the budgets for the procurement of equipment, staff, and technical operation. At the same time, operating a network is expensive, so planners should try to purchase the best equipment they can afford to get the best possible results. For example, communication operating costs for a poor station are the same as for a good one; the difference will be in the quality of the data.

When it comes to buying equipment, one normally goes through a bidding process to find the best solution. Here one needs to decide if the bidding will be for the complete system or parts of it. It may be possible to select a number of preferred suppliers for different parts. It is also wise to look ahead. A common problem is that the cheapest bidder may not have the best solution in terms of durability of equipment and future operational costs. The evaluation process, therefore, should consider expected operational costs. When selecting a bidder, one should be aware of expected limitations of the system provider when it comes to data processing and seismological knowledge. This

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knowledge may have to be acquired elsewhere, for example, through participation in international training courses.

When the equipment arrives, giving the operator the main responsibility for the installation will result in the most knowledge gain. While turn-key solutions are often attractive and quick, the operator may not learn enough to even take on the operation upon completion. When the network becomes operational, the data will have to be stored and processed. Again, this requires tools and skills, and one may have to learn from other places to establish the routines. Collaboration and data exchange can help to improve the overall output from a seismic network.

When it comes to software there is the general choice between commercial and open software for both automated data processing as well as interactive analysis. In our view, there are often good reasons to prefer open software, as commercial products can be quite limited, may not have a broad user base, and often lack user support.

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There are many possible reasons why things do not develop as outlined. Political pressure to act fast may be the worst. Another common problem is that it is often easier to get one-off funding for equipment compared to funding for long-term operation. From our experience, the following scenarios are possible:

A sophisticated network gets installed without considering the need for well-qualified staff and long-term operational funding. The result is that the data do not get utilized to their potential and the network deteriorates over time.

A turn-key system gets installed with the expectation to generate perfect automatic reports. The result is that due to an operator's lack of skills the required adjustments to the automatic system don't get made.

Over the years different systems are installed, with different purposes, without being integrated. The result is a number of stand-alone systems, and overall outcome is much less than what could have been achieved with a long-term strategy for integration.

Planners succumb to pressure to select a cheap solution and the equipment doesn't meet required specifications and/or may not be durable. The result is operational costs that are greater than anticipated.

A network gets installed through an aid project without knowledge transfer. The result is that the network cannot be maintained due to a lack of skills and resources.

The list goes on. However, in our view many of the pitfalls could be avoided by increasing the knowledge at the very start by seeking help from experienced institutions and participating in existing training opportunities. Training can take different forms including specific courses, workshops, and formal education. From our experience, hands-on training on specific problems is essential, in addition to more theoretical classes.

It is important to realize that skills and knowledge, and a sufficient operational budget, are essential to sustain a seismic network. It often seems that too little emphasis is spent on this part; instead one mostly worries about the initial investment. Overall, slow progress with the setup of a network, during which skills are developed, may result in better results after some years. We are aware that this requires patience and courage. However, if this is not an acceptable solution, and one has to go for a turn-key solution, it is still important to plan for operational funding and the development of skills. Much of what we say here is common sense. However, the reason for writing this piece was that it does not always seem to be applied.

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