

EARTHQUAKE PREDICTION VOLUNTEERS: WHAT CAN THE UNITED STATES LEARN FROM CHINA?

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The well-documented success of the People's Republic of China in pinpointing the time and place of the Haicheng earthquake of February 4, 1975, facilitating massive evacuation of the population to safe locations, is without parallel in western society. In spite of failure to predict the tragic Tangshan quake of July 28, 1976, other less well documented successes in earthquake prediction, such as the Western Yunnan quake of May 29, 1976, and the Szechwan quake of August 16, 1976, lend credibility to the Chinese achievement. Chinese and American earthquake prediction enterprises are not greatly different in their scientific foundations or in the way they make long-term and medium-term predictions, except for a more pragmatic emphasis in China and more concern with theory in the United States (American Seismology Delegation, 1975; Haicheng Earthquake Study Delegation, 1977). The striking differences are the Chinese success in pinpointing the prediction within a day or two and their extensive use of amateur observer groups in achieving this end. The massive organization and effective use of volunteers, as yet missing from United States earthquake prediction efforts, raises many interesting questions for sociological investigation.

No meaningful analysis of the use of volunteer groups in earthquake prediction can

be made without considering the broader use of volunteers and the relationship of volunteerism to the larger social structure. Western stereotypes of socialist society often depict a sort of regimentation that leaves little room for spontaneity and volunteerism. An influential study of volunteer services in hospitals (Institute for Directors of Volunteer Services in Mental Hospitals, 1961) seems to promote this view with the following assertion: "It has been observed that in countries where there is complete state medicine, as for example in England, there is little volunteering" (p. 236). Similarly, Chinese stereotypes of capitalist society make it difficult for the Chinese to believe that millions of Americans volunteer their services for worthy causes on a regular basis. When the author explained to a group of Chinese how Americans used volunteers in many important arenas of service, he was quickly prompted by their leader with the remark, "Of course, they are paid for their work!" The author's assurances on this score were received politely but with obvious disbelief. The misunderstanding was not restricted to the Chinese. On two occasions the author heard American earthquake scientists explaining to their Chinese counterparts that the nature of American social structure precluded the use of volunteers, so it was necessary to organize our earthquake pre-

diction enterprise differently from the Chinese.

In spite of the misconceptions, Chinese and American society are surprisingly alike in the willingness of the people to volunteer their time and effort in support of community service. The American failure to use volunteers in earthquake prediction is in marked contrast to the widespread use of volunteers in other realms, such as weather forecasting and health care. Nevertheless there are important differences in the way volunteers are used in the two countries. In light of steps that have been initiated by the United States Geological Survey under the leadership of Peter Ward (1978) for trial use of volunteers, a broad examination of sociological dynamics of volunteer participation should be useful at this time.

The specific objectives in this paper are three: to describe the Chinese system by which amateur observers are incorporated into the earthquake-prediction enterprise; to seek to understand the dynamics of the amateur program — how it deals with the problems of organization and function that are inherent in such an effort; and to explore the applicability of the Chinese program of amateur observation to the American scene and to other western societies. For at least two reasons these objectives cannot be achieved without also examining the broader experience with the use of volunteers in the United States. First, it has not yet been possible to penetrate intimately enough into the working of Chinese amateur groups to diagnose the problems in the system through direct observation and to identify at first hand the crucial mechanisms that make them effective. American volunteerism, by contrast, has been subjected to a good deal of searching investigation. To a considerable extent the findings from these latter studies can suggest what to look for in the study of Chinese amateur groups. Second, some exploration of the current extent and nature of volunteer service in the United States is needed as a basis for judging whether a program of

amateur observation might succeed in the United States and in similarly constituted western societies.

The discussion will be organized in five steps. First there will be a brief description of the organization of Chinese amateur groups and their part in the total earthquake prediction program. Second will be a review of some evidence on volunteer service in the United States, especially for the purpose of ascertaining readiness to volunteer in a program of earthquake prediction. Third will be an examination of the dynamics and problems of programs making extensive use of volunteers, related to the ways in which the Chinese appear to have dealt with these problems. Fourth will come analysis of the amateur—professional—client relationship as an integrated system, in which the volunteer tends to be replaced with the true amateur. A brief statement of conclusions will complete the discussion.

AMATEUR GROUPS IN CHINA

The technical organization of earthquake prediction activities in China centers in the State Seismological Bureau in Peking, in provincial seismological bureaus and brigades, and in a variety of seismological stations, offices, and observatories. Responsibility is largely decentralized to the provincial bureaus. The Institutes of Geophysics and Geology in Peking are major research centers, but do not participate directly in prediction. Reporting to the local seismological stations and observatories are the amateur groups. They range in number from one person to several. The Chinese estimate that more than 100,000 amateur groups are busy making daily observations. In late June, 1976, we were told that about 200 groups were operating around Peking. The term “amateur” conveys a triple meaning. Amateurs are not professionally trained as geologists or seismologists, though they may have technical training for the

specific kinds of observations they are making. Amateurs are not full-time professionals, but make their observations in addition to carrying out their main vocations. And amateurs are volunteers, who receive no pay or work credits for the time they devote to earthquake prediction (for an account of the use of amateur groups based strictly on published Chinese sources, cf. Gimenez, 1976; and for a typical English-language report from a Chinese source, cf. "A Report from an Earthquake Area," 1976).

State Seismological Bureau officials divide amateur groups into three types. The largest and most sophisticated are known as *backbone groups*. Apparently these groups fill much the same function as seismological stations, thus extending the professional network. Backbone groups are equipped with sophisticated seismic instruments and have teams of personnel. The equipment and the presence of technically trained personnel make it possible for these groups to conduct some research. Backbone groups receive reports from less sophisticated groups and help them verify and interpret their observations. With access to a panoply of data these groups are sometimes able to formulate earthquake predictions.

Around Peking there are about twice as many *ordinary groups* as backbone groups. These groups may consist of several people. They have instruments of simplified design. They take considerable pride in manufacturing their own instruments and in trying out innovative designs. Electrodes to measure telluric current and devices for recording changes in the earth's electromagnetic field are commonly used. Anyone can purchase a book that describes some of the most popular devices and gives instructions for making them. These groups make regular observations and compile records and exchange information with other ordinary groups and with professionals. Both backbone and ordinary groups play a part in diffusing knowledge about earthquakes to the general population. A

typical ordinary group would consist of middle school (high school) students working under the supervision of a high school teacher; or factory employees making use of some of the equipment and technical expertness available in the factory setting.

By far the largest number of groups consist of persons without specialized training, and are referred to as *macroscopic observation* groups. These groups are small, consisting usually of from one to three persons. They make regular observations, but keep no records and only report to the nearby seismological station if they observe some anomaly. Although officials we talked to from the State Seismological Bureau could give us the number of ordinary and backbone groups around Peking, they could not hazard a guess concerning the exact number of macroscopic observation groups. The typical macroscopic group would consist of peasants who made daily measurements of water levels in local wells and watched for muddying or bubbling of water, looked for unusual animal behavior and earth lights, and listened for unusual earth sounds. The observations they make require no specialized instruments and are rooted in folk wisdom.

Ordinary groups fit best the Maoist ideal of amateurs whose enthusiasm leads them to gain technical knowledge which is integrated with folk experience so as to produce insights of interest to professionals. The much advertised record of suddenly decreased telluric current just prior to the Haicheng quake was produced by such groups (Muller, 1976 pp. 17–18; Haicheng Earthquake Study Delegation, 1977, pp. 249–251). But the macroscopic groups conform most closely to the ideal of peasants applying traditional folk wisdom.

While the amateur enterprise is often referred to as a people's war against earthquakes, it is in some ways a far cry from the western notion of a grass-roots enterprise. First of all, each amateur group is a unit within and subject to control by a civil unit. Most amateur groups are

units established within rural brigades or communes, factories, and schools. A few are lodged in urban street units. In effect, each amateur group is a "committee" of the sponsoring group. The amateur group membership is determined by the factory committee or the commune or brigade committee, and each amateur group functions under the authority of the revolutionary committee in charge of the civil unit. Second, amateur groups are established at the instigation of either the local civil unit (commune, factory committee, etc.) or seismic station personnel. The latter visit factories, communes, schools, and other units where reports from an amateur group would be useful in order to request the establishment of groups. The result is that groups are in operation where they are expected to be most useful or where the equipment and technical expertness are available.

The relationship between civil units and seismic stations incorporates a strict line--staff distinction. The seismic station receives observation reports and provides technical advice to the amateur group, but holds no authority over it. Authority comes from the civil unit. While the primary responsibility for interpreting and relaying the observations lies with the seismic station, the amateur group also reports to the civil leadership.

The amateur groups have a well-identified part to play in the eventual production of an imminent earthquake prediction. Although some groups are in operation continuously, their chief function is fulfilled after a medium-term or short-term prediction has been issued. The amateur groups then provide much more intensive coverage of the area at risk than would be possible using only scientific personnel, and their observations concentrate on premonitory signs that are expected shortly before a serious earthquake. This complementarity can be illustrated with a chronology of the Haicheng prediction. At a national conference in 1970 the southern Liaoning region was designated as an area that warranted special observation.

Three years of scientific studies strengthened the initial judgment and by 1973 some efforts to supplement scientific study with amateur observation were underway. The turning point was a meeting in June, 1974, at which a magnitude 5–6 earthquake was predicted within one or two years. Between June and November a massive effort was launched, including the establishment of many hundreds of amateur observation groups in the area at risk. Animal and well-water anomalies in mid-December appeared to presage an earthquake of 4.8 magnitude on December 22, but the prediction for a serious quake remained in effect. Amateur groups continued to report anomalies during January, and earthquake disaster information was disseminated. Anomalies intensified toward the end of January and the beginning of February, culminating in evacuations on February 3 and 4 and occurrence of the magnitude 7.3 quake centered near Haicheng at 7:36 P.M. on February 4. The crucial contributions of the amateur groups came during the last month and a half before the quake.

VOLUNTEERISM IN THE UNITED STATES

In the following brief review of volunteerism in the United States we shall first note the extent and range of volunteer service, then look more closely at some patterns of volunteer activity that occur in settings that are reasonably analogous to the earthquake prediction situation.

Extent and range of volunteerism

The extent of spontaneously offered voluntary service in the wake of a natural disaster has been extensively documented (Fritz and Matthewson, 1957; Barton, 1969). But it is not obvious that comparable enthusiasm for voluntary activity will accompany the uncertain *prospect* of disaster. Hence we must inquire about volunteerism under more routine circumstances.

In a sample survey of Americans over thirteen years of age in April, 1974, conducted by the U.S. Census Bureau (ACTION, 1975), 24 percent reported having done some "unpaid volunteer work" for a service organization during the preceding year. A more conservative estimate of service might include only the 60 percent of volunteers (or one in seven adult Americans) who contributed their time and effort at least once a month on a regular basis. For all people who volunteered in a given week the median time spent was from two to four hours. The rate of volunteer service is somewhat increased by comparison with a similar survey in 1969. Volunteer rates were higher for women than men, for married than single persons, for whites than nonwhites, for employed persons than unemployed and nonworking persons, for persons in the higher income and education categories and the middle age range (25–44 years). These findings and other evidence from the survey plainly contradict any assumption that mostly people with nothing to do seek volunteer work to fill their time.

Most of the volunteer work falls into three categories: 50 percent is in religion and 15 percent each is in education and health. The integral relation of volunteer work to the life cycle is suggested by the peaking of voluntary educational activity during early adulthood, by parents of young children, and the peaking of health volunteering in later adulthood.

When exploring the possibility of developing a volunteer program in connection with earthquake prediction, it is important to estimate the pool of potential volunteers who might respond to the call for assistance in time of emergency. This pool may be much larger than the number of persons now volunteering. A recent investigation sought to estimate the pool of potential volunteers in one area of service, namely, civil defense (Nehnevajsa, 1976). Americans over 17 years of age were asked in 1972, "If the call went out for volunteers to participate in a community Civil Defense

program, would you personally be likely to volunteer?" Fifty-four percent answered "definitely" or "probably yes." Analysis suggested that civil defense would draw upon a somewhat different pool than other kinds of voluntary activity, since men, youth, and blacks were more likely to volunteer than women, middle-aged adults, and whites. Although the majority of nonvolunteers did not give opposition to civil defense as the reason, the fact that southerners were readiest to volunteer coupled with the stronger military tradition there cannot escape notice. It is also plausible to infer from a combination of findings that willingness to volunteer is positively related to belief in the need for civilian defense (i.e., the probability of war) and optimism about the possible outcome of war (i.e., survival chances).

The impression that organized volunteerism has recently increased, based on the comparison of 1969 and 1974 findings, is reinforced for a longer time span by numerous studies of volunteers in particular service areas. For example, Gillette (1968) chronicles the growth of the youth work camp movement. In 1920 the Fellowship of Reconciliation organized volunteer efforts to reconstruct the war-damaged French town of Esnes. The work camp pattern became the model for over 250 organizations in many countries that now recruit, train, and send abroad young volunteers. The United States Peace Corps, though not strictly a volunteer organization, was patterned after this tradition. Ewalt (1967) points out that the interest of college students in providing voluntary services for the mentally ill has only been manifested on a substantial scale since 1954. Naylor (1967) in reviewing the use of volunteers by private social agencies concludes that more people are willing to volunteer time and effort on behalf of communities and fellow citizens than ever before.

Whether the disposition to volunteer has increased or not, the deliberate cultivation of volunteerism by service agencies has clearly in-

creased. Routh (1972) points out that agencies are faced with the prospect of funds that are increasingly insufficient to provide needed services in health, welfare, and social services. Consequently they must make "more intelligent use of carefully selected and well trained volunteers" (p. 3). Janowitz (1965, p. 2) observes: "For years schools have used volunteers for many non-academic functions. In recent years they have begun to develop academic programs using volunteers."

Volunteerism in science

The history of volunteer involvement in scientific activity is a long one (Whitman, 1976). Two such programs merit brief description because of parallels to the circumstances of earthquake prediction. The Moonwatch program was established to provide volunteer support for professional satellite tracking from 1956 until 1975 (Cornell, 1975). Volunteers were to locate satellites visually and report their sightings so as to facilitate the more precise optical tracking by the twelve sophisticated instruments placed around the world. The call was for amateur astronomers, familiar with the use of telescopes, to work together in teams. A specially designed wide-angle telescope was provided for the amateurs, but an estimated forty percent built their own units in home workshops. The appeal for volunteers was made through *Sky and Telescope* magazine and personal appeals to astronomy groups. Over 200 teams in the United States and abroad were maintained throughout the years of peak operation. A supplemental network of airline flight officers from around the world was developed to gather data on objects seen from the air. As the program matured, more serious-minded amateurs replaced the less serious ones. Altogether it has been estimated that 400,000 observations worth more than \$ 14,000,000 to the program were made by the volunteers.

While the Moonwatch program came at a time of aroused public interest in satellites, the

U.S. Weather Service has had a program using volunteer weather observers since the end of the nineteenth century. The program includes two types of volunteer observers, namely, climatological observers and severe local storm spotters. An estimated 12,500 climatological observers have been supplied with sets of simple instruments with which they make daily observations and mail their records periodically to the weather service. They are supplied with a handbook (NOAA, 1972) explaining the instruments and specifying the way in which observations and reports are to be made. Another 400 observers supply the Weather Service with climatological data from their own instruments. Many of the observers are farmers, though a wide range of occupations is represented. Some of the same observers have served for several decades, and families sometimes carry on the observer tradition. However, one Weather Service official reported that many of the observers must now be handled with kid gloves, and that turnover has increased in recent years and recruitment has become more difficult. Fulltime Substation Network Specialists are hired to recruit volunteers to the program. The Weather Service gives special service awards as recognition for loyal service over extended periods of time.

While climatological observers work continuously, tornado spotters in the *Skywarn* program are on standby duty only during the tornado season each year, and are alerted as needed when tornado watches are in effect. The average tornado watch lasts about three hours, but may run as long as six to eight hours. Each spotter has an assigned location to which he reports when called. A tornado watch is announced when meteorological data indicate that conditions are favorable for the development of a local tornado. But only direct visual observation can establish the existence and pinpoint the location and trajectory of the destructive funnel cloud in time to warn people who are in greatest danger. Weather Service handbooks show the observer what to look for

(NOAA, 1973 and 1975). The most essential aspect of this arrangement is the capability for quick communication. Hence two requirements for volunteers are that they have ready access to a suitable outside location such as a hilltop or the top of a tall building, and that they have facilities for quick communication, such as police or "ham" radios or Civilian Band equipment. More people volunteer for this corps than can be accepted, so the Weather Service is able to be selective. National amateur radio and CB organizations encourage their members to volunteer as tornado spotters. Recruitment is decentralized under the heads of local weather stations, who determine the needs in their areas.

Review of the Moonwatch and Weather Service programs suggests that volunteers can be recruited to make observations ranging from crisis sightings to routine record keeping, and from obviously life-saving information to the collection of research data. In each of these programs the observer is or becomes more expert than the average person in the use of some equipment and in knowledge of some phenomenon of public concern.

Grass-roots prediction activity

Although a serious effort to organize volunteers into the earthquake prediction program in the United States is only now in the planning stage (Alexander, 1978), at least two "grass-roots" volunteer groups have sprung up in the Los Angeles metropolitan area. "Earthquake Forecasters" consists of approximately 25 amateur radio operators who have discussed earthquake forecasting among themselves by radio. The key figure is an amateur student of earth sciences who purchased a tiltmeter at a government surplus sale and installed it in his basement, and reports that he observed dramatic tilt anomalies preceding the 1971 San Fernando-Sylmar earthquake. The group has made unsuccessful efforts to get technicians from a local university to install tiltmeters in all of their basements, with a plan to report

anomalies immediately to the university seismological laboratory.

In 1976 another local resident with talents as a gadgeteer and an interest in earthquake dynamics developed a twelve-inch spirit-level "tiltmeter" and organized a group of volunteer observers under the name of "Quakewatchers." Membership was advertised in the local press, with a membership fee that included the price of a tiltmeter. Members were to keep records and turn them in periodically, and were given a "hot-line" number to call in case of any striking anomalies. Quakewatchers received some television coverage, mostly subjecting the supposed tiltmeter to ridicule. Perhaps because of explicit disparagement by local seismologists, Quakewatchers reached fewer than 100 members, and few of the members have cooperated in the organization's reporting procedures.

While neither of these groups has made a significant impact on earthquake prediction, they incorporate the same interests in amateur science, technical equipment, and public service found in Moonwatch and Weather Service programs. Although abortive in the absence of support by recognized scientists, and naively conceived, they suggest the existence of interests that could be tapped in an appropriately sponsored program. At least one California legislator has publicly sought to promote the establishment of an amateur network following the Chinese example (Quakewatchers Network Proposed, 1977).

THE DYNAMICS OF VOLUNTEERISM IN UNITED STATES AND CHINA

In an early study of the use of volunteers by the National Foundation for Infantile Paralysis, Sills (1957) identified two broad organizing problems: "Maintaining the interest of members and preserving organizational goals." To these, which we shall call the problems of *incentive* and *control*, we add two others. The problem of *recruitment* includes locating nonprofes-

sionals with suitable skills and interests and involving them in the activity. The problem of *communication* has special significance for an activity like earthquake prediction in which timely and selective transmission of information is critical.

Recruitment

The image of uneducated Chinese peasants watching their animals and their water wells appeals to a western mystique of volunteerism as an expression of self-reliant initiative requiring only good intentions and common sense. While there are volunteer tasks in America that require no training they are often viewed as menial. Short periods of training are included in some volunteer programs. But many of the best known organizations using volunteers seek recruits who already have technical skills and equipment. Moonwatch recruited people who were already amateur astronomers, and Skywarn seeks ham radio and CB operators with their own equipment. The American Red Cross uses 80,000–100,000 volunteers a year but looks for people with professional skills that are directly useful in their disaster operations. Actual practice in Chinese amateur groups is closer to American experience than to the mystique. At the Tankangtzu Spa, staff physicians man the amateur unit that keeps daily records of radon content in the Spa waters, using sophisticated equipment already available there. At the Metallurgical and Geological Exploration Company in Liaoning Province, a professional geophysical exploration specialist supervises a group of telephone operators in making magnetic field observations and other tests using equipment on hand for metallurgical exploration. Middle School students who are studying science serve as volunteers under the supervision of science teachers. Only the “macroscopic” groups rely principally on untrained personnel. But here intimate familiarity with particular animals or terrain is needed to recognize anomalies.

The fear of having to accept whoever walks in is often mentioned by American scientists as a deterrent to launching a volunteer program. But American experience indicates that volunteer units are like social movements in recruiting new members through the social networks in which existing members are involved (Bolton, 1972, p. 557; Gerlach and Hine, 1970, pp. 79ff.). The rule is not mass appeal but referral from established volunteers who informally preselect the new recruits for the appropriateness of their interests and skills. Here, too, the Chinese rely much less on mass appeals than on a selective approach to communes, factory committees, and schools. Recruitment through schools, Four-H clubs, amateur science groups, and senior citizen organizations rather than mass appeal would be consistent with the experience of the most successful organizations using volunteers in the United States and of the Chinese earthquake prediction program.

Incentive

The motivations for engaging in volunteer activity in the United States are diverse but generally come to a focus through the desire (a) to be of service, (b) while engaging in interesting activity, (c) in the context of gratifying social relationship, and sometimes (d) with the prospect of more tangible personal benefit. These broad motives only become effective as they acquire more specific meanings from the potential volunteers' social settings and the social organization of the enterprise into which volunteer activity is incorporated. Examples of the former include the possession of underutilized skills and, sometimes, equipment, so that many retired persons and amateur radio operators and Civilian Band radio equipment owners are anxious to engage in relevant interesting work; a restricted social life which has in the past induced many traditional housewives to seek volunteer activity for the sake of the social relations involved; an interest in career development which often leads young

people to seek what they hope will be an apprenticeship experience in volunteer work; and a personal stake in the program which leads the parents of school children to give volunteer service in the schools. It seems evident that the pool of such potential motivations for participation in an earthquake prediction is more than adequate in both China and western nations. But potential motivations alone are not sufficient to sustain dedicated participation. As Schindler-Rainman and Lippett (1972, pp. 53–54) remark:

The unreal expectations given in recruitment are a frequent cause of 'motivational shock' later on. Discrepancies between expectation and reality may be discovered in the amount of time required for the activity, the type of work, the amount of support from professionals, the type of clients, the available facilities, and many other areas.

The critical question is therefore whether the volunteer activity can be organized so as to foster rather than undermine personal incentives for participation.

An important aspect of the organization of volunteers is the autonomy accorded them. Sills (1957) noted that one of the early crises in the National Foundation for Infantile Paralysis was resolved by returning a fraction of the funds gathered to local chapters for disbursement at their discretion. Chinese amateur groups are not permitted to make earthquake predictions and are directly under control by both the local civil authority and the seismic station. Nevertheless the dual lines of authority undoubtedly enhance the *de facto* autonomy of the amateur groups because of the possibilities for coalition formation and discretion in the relative use of the two lines of communication. Ordinary and backbone amateur groups also have some discretion in the types of observations they will make and the equipment they will acquire. The autonomy motive is conspicuous in the two grass-roots prediction groups in Los Angeles already described. The problem of finding a suitable formula for assuring reasonable autonomy will undoubtedly be

critical to the success of any earthquake prediction volunteer program. We will return to this problem again under the discussion of control.

Social recognition by clients, professionals, and the community is crucial in sustaining the incentive for participation. Practically all of the analyses of volunteerism in the United States stress the lack of appreciation (e.g., Routh, 1972) or the lack of appreciative feedback (Schindler-Rainman and Lippett, 1977) as a principal reason for loss of volunteer interest. Typically it is the professionals rather than the volunteers who receive credit for the success of a joint enterprise. Artificial devices such as the Weather Service certificates of recognition are widely used, but are probably less effective than sustained relationships providing for continuous recognition. The Chinese system establishes such relationships with both the community and the professionals. Because the amateur group is the agent of a civil unit and not merely of the earthquake prediction establishment, the local revolutionary committee is continuously apprised of the group's activities and the entire brigade, commune, or factory can take pride in the accomplishments of their amateur group. Although American society has few civil units as close to the community as the Chinese communes and brigades, a similar effect may be achieved through organizing volunteer groups in schools, Four-H and scouting organizations, local chapters of labor unions, and similar units. Community recognition available through such an arrangement is much greater than would be available if the U.S. Geological Survey were to organize its own groups.

The Chinese pattern of decision by conference also probably contributes to social recognition by both the community and the professionals. Some American scientists have already informally advanced proposals for volunteer observers to report their observations periodically by mail to the scientific laboratory, without any provision for the volunteers to participate with scientists in the discussion of their data

nor to receive feedback concerning the use made of their reports. This sociologically naive proposal is in contrast to the Chinese practice whereby the decision to forward potential crisis information to the seismic station is made in a face-to-face conference between community leaders and amateur group members, and the decision as to further disposition is made in a face-to-face conference involving professionals from the seismic station, members of reporting amateur groups, and representatives of local civil units. Some such element included in any American plan would clearly facilitate the sustained incentive of the volunteers.

The sense of importance and service may be both the most important and the most precarious element in the volunteer incentive complex. Stanton (1970) underlines the disillusionment felt by volunteers as they come to view the programs in which they participate as mere ritual and as ineffective in contributing toward their stated objectives.

... many of our conventional philanthropic associations have become the producers of a kind of modern morality play – a civic drama – in which community leaders and would-be leaders are provided a context for the presentation of a well-publicized altruistic self (pp. 19–20).

The sense of importance is affected by the available cultural values into which the activity can be fitted, the nature of the work, and the time span of the activity. The major Chinese revolutionary value of self-reliance figures largely in explaining and justifying the amateur group program. Through amateur groups, local communities can do for themselves what the centralized organization could not do alone. A similar value of community self-help has been important in giving meaning to charitable volunteer activities in the United States (Sills, 1957). But there is also a populist value in American society, often expressed in the belief that the people can accomplish the same things more simply and less expensively than the experts. This theme is evident in both of the grass-roots groups in Los Angeles. Populist

values can quickly lead to polarization between volunteers and the scientific establishment and to disillusionment. There is, however, a parallel in Chinese society in the stress on folk wisdom, which we shall examine further in a later portion of this paper.

The often routine and intrinsically uninteresting nature of the observations required, coupled with the necessity for sustained observation over extended time periods in the absence of obviously urgent need and effect, may pose the crucial problem for earthquake prediction. The problem of sustaining a fairly routine kind of activity is dealt with in two ways in the Chinese program. First, the most concentrated use of amateur groups occurs after a medium-term prediction has been issued, so the work of the amateur groups is usually critical for only a few months. We do not know how frequently and for how long the Chinese amateur groups have remained effective after a significant earthquake or the cancellation of a long- or medium-term prediction. Second, the Chinese have made use of high school students who serve during a period of personal learning and growth and then graduate and are replaced by other students. Similar principles can easily be incorporated into the organization of American amateur groups.

Earthquake prediction poses still another difficulty in maintaining the sense of importance. Because the Chinese predict earthquakes on the basis of a preponderance of evidence of all kinds and because the information about amateur groups made available to western observers has been selective and illustrative rather than representative or comprehensive, we cannot yet say with certainty that the amateur groups have made a decisive contribution to valid prediction of earthquakes in China. It is always possible that anomalous animal behaviour and well-water variations may be shown either to be unreliable as earthquake precursors or mere epiphenomena of such precursors as foreshocks that can be identified more reliably through networks of scientific

instrumentation. As the usefulness of amateur reports is debated publicly, volunteer morale may suffer. The Chinese have not publicly admitted this possibility and have forestalled the diffusion of the idea by linking skepticism to politically abhorrent leanings and by carefully controlling communication. In American society it will be essential that the possibility be openly acknowledged from the start and that incentives be shaped accordingly.

Along with the sense of importance comes a sense of expertness which gives the volunteer activity special meaning. Sills (1957, p. 237) observed that the volunteers "feel they are the equals of doctors," in a society in which the relationship between professional and layman is normally quite hierarchical. The sense of expertness is cultivated in the Chinese program, especially for backbone and ordinary groups, by using the groups to carry on earthquake education programs in the community and by encouraging groups to manufacture and sometimes even devise their own equipment. The same pattern can be followed in the United States, and some of the earthquake prediction activities can be scheduled as part of a broader science education program.

In recent years the emphasis on service in volunteer activity has been partially displaced by a concern for personal development and even career development. Volunteer activity has been valued either as a stepping stone to more significant volunteer activity or as apprenticeship for eventual paid occupational work. Women have questioned whether unpaid volunteer work is not exploitation, unless it serves as a stepping stone to paid employment (Loeser, 1975). Integration of Chinese amateur groups into the community structure, so that they are comparable to specialized committees in American organizations, may have lessened the potential sense of exploitation in China. But we saw evidence in China of a transformation of what had previously been women's volunteer work in education into paid vocational activity, paralleling developments in the

United States. At least in western nations it will surely be important to design volunteer programs specifically to provide for personal growth rather than simply repetitive service.

Control

The problem of control involves dependability, accuracy, and following instructions precisely, and it also means dealing constructively with a tendency for volunteers to be "carried away" by their own enthusiasm and overconfidence. The control problem exists at two levels, namely, control of the individual and control of the volunteer group.

Control of the individual is achieved in China through the dual lines of authority. By making the amateur officially responsible to the local revolutionary committee the system institutes considerably more effective discipline over the individual than could be exercised directly by seismic station officials. The individual's reputation among his neighbors is at stake rather than his standing in a segmented relationship with a remote group of professionals. In the United States the same effect can be achieved by working through existing organizations that are central to people's social lives at the time.

Control of the amateur group poses somewhat more of a problem, both in the United States and China. Official policy is for professionals to go into the field with amateur observers to verify any anomaly which serves as the basis for issuing an earthquake prediction, though it is doubtful that this is possible except by sampling when there is a flood of reports. The very establishment of autonomy, important in fostering incentive, often impairs control. The Chinese are indeed ambivalent over the proper balance between autonomy and control. While the normal rules provide that earthquake predictions should only be issued by the provincial seismological bureaus, the theme of self-reliance is illustrated with examples of a local brigade or commune leadership in collaboration with the amateur group

issuing a prediction on which the community acted with resultant saving of lives.

Adequate resolution of the problem of balancing autonomy and control probably depends upon conceiving the volunteer group as a quasi-professional group, according to the meaning of *amateur* which we shall address later.

Communication

In addition to the usual problems of two-way communication and feedback, earthquake prediction requires that there be prompt communication of information about potential premonitory signs, that there be effective procedures for signalling those bits of information that merit immediate and extraordinary attention, but that emergency signalling be highly selective. Although the Chinese have a highly rationalized communication scheme, there are hints that it does not always work perfectly. In an unguarded moment one Chinese professional referred to the constant interruption of their scientific work by peasants bringing in reports of anomalies. And there have been unconfirmed reports from China that accounts of anomalies observed up to a week before the disastrous and unpredicted Tangshan quake had been forwarded but not yet analyzed in the higher-echelon decision centers.

To the extent to which issuance of an imminent prediction is preceded by increasingly immediate and localized designations of earthquake risk, comparable in principle to issuance of a tornado watch, the problems of selectivity and of signalling critical information are minimized. But until we have reached a stage of confidence that earthquake predictions will develop in this phased and progressive fashion, the problems can be serious. Even with computerized scientific information, lags of a few weeks in processing data may have prevented issuance of timely predictions of minor quakes in the United States. The Chinese have simply not requested their macroscopic observation groups

to forward information except when anomalies are observed. But anomalies are relative, and they often occur for reasons not associated with earthquakes, so a great deal of data not indicative of an earthquake must still be scanned promptly. Furthermore, it is essential that detailed and current records of animal behavior, well-water level and quality, and similar phenomena be maintained and transmitted regularly so as to be sure that the crescendo of expectation based on other seismic indicators does not artificially create a corresponding increase in volunteer observations of anomalies.

It is essential that the system of routine reporting be supplemented by an arrangement for immediately forwarding and scanning data that could signify an emergency. For this to be effective reports must come from trained and disciplined observers rather than be volunteered from the public at large. The observers must be able to draw upon intimate experience and understanding to identify the data that should be forwarded immediately. In China the use of zoo keepers whose intimate familiarity with the habits of their animals enabled them to recognize true anomalies of animal behaviour and of peasants observing their own animals satisfied this requirement. In the United States Four-H Club members who own and care for their own animals and study their health could make such discriminating observations. Volunteer observers could also be taught, as macroscopic observation group members in China were not, how to compare current data with immediate and longer term trends on the basis of the daily record they keep in deciding what information to forward on an emergency basis.

A quickly mobilizable filter unit is probably the other essential element if selective communication of emergency information is to be attained. The Chinese use the conference with local community leaders as the first stage filter and the conference with seismic station professionals as the second filter before observation

reports are forwarded to the provincial seismological bureau. The seismic station is critical because many amateur groups report to it. A report from a single group can be discounted at this level, or confirming reports from several groups can become the basis for alerting the provincial bureau. Perhaps the ideal filter group for an American program would consist of experienced representatives from the organization sponsoring the volunteer group and one scientist from the U.S. Geological Survey or university seismological laboratory to which the reports are finally sent.

PROFESSIONAL, AMATEUR, AND VOLUNTEER AS A SYSTEM

Thus far we have looked at the dynamics and problems of using volunteers, or amateurs, without attempting to examine the relationship as a whole system. There are two contrasting ways of conceiving the system. From one perspective the scientists and their clients constitute the system and volunteers are merely resources at their disposal. Volunteers have no unique contribution to make other than their service. From the other perspective the amateurs and scientists are equally essential parts of the system, along with the clients. Besides their service the volunteers contribute distinctive wisdom and sometimes technical proficiency that complements the knowledge and skill of the scientist.

There is a tendency to think of the volunteer in the former sense in the United States. Many of the incentive problems in American volunteerism arise from the volunteer's peripheral status, devoid of intrinsic importance and excluded from significant decision making by professionals. The peripheral status may also contribute to control problems, since it fuels a populist tendency to rebel against professional hegemony and to denigrate expert knowledge in favor of common sense. When volunteers have their own areas of expertise, like medical volunteers for the American

Red Cross or expert amateur radio operators for the Weather Service, a relationship of greater mutuality can be developed and many problems of incentive and control recede.

The Chinese view is epitomized in the phrase from Mao Tse-tung that "science walks on two legs."

... ancient traditional knowledge together with more modern advances made through regular scientific channels are one leg. The broad masses of ordinary people who have always been denied access to scientific developments have become the other leg. Basically, the idea of walking on two legs means to exercise the underdeveloped one, rather than putting all resources into the stronger one. It does not mean cutting off the stronger one in favor of the weaker . . . (Science for the People, 1974, p. 6).

This philosophy means an effort to blur the distinctions between experts and ordinary people and to encourage scientists to work with peasants and laborers and learn from them.

Underlying the encouragement of mass participation in science we may recognize two assumptions. First, the Chinese leaders assume that practical work experience may provide scientifically-relevant insights which specialists not involved in practical work do not share. Second, they assume that knowledge accumulated through trial and error by millions of common people over many generations constitutes a precious scientific resource which should not be arbitrarily subordinated to theoretical ideas formulated by elite specialists (Richter, 1976, p. 15).

Like western ideals, Maoist ideals are probably converted into practice most effectively when implemented through a congruous social structure. Within the limits of our experience, scientists and peasant leaders treated each other respectfully. But except for the serious attention to traditional wisdom on such matters as animal behavior and earthquakes, we saw no clear evidence that peasant input significantly affected the way in which scientists think about earthquake dynamics. The mutual respect requires more than the doctrine. It flourishes in situations like those described by Joshua Horn (1969), a British physician who worked in China with medical teams in which he learned from nurses and paraprofessionals

whose experience with Chinese diseases, with improvising in the absence of western medical resources, and intimate familiarity with the Chinese people complemented his own more advanced medical knowledge.

The Chinese system also incorporates a political theme quite foreign to American science. The theme is expressed through the authoritative designation of scientific priorities by political leaders, the constant effort to show that scientific theories are extensions of ideological dogma (scientists find that there is dialectic in the physical dynamics of earthquake as well as in society), the active involvement of political personnel in scientific as well as policy decision making, and the scapegoating of political figures for limited scientific achievements. A visitor to China is given the impression that the high priority assigned to earthquake prediction by national political leaders is a major incentive for participation in amateur groups, but American experience has demonstrated that volunteer programs involving thousands of people can be maintained without this kind of sponsorship. While the political presence is employed in China to control elitist tendencies among scientists that might otherwise diminish their attention to the work of amateur groups, this is an artificial and often precarious way of accomplishing this end. A program for collaboration between professionals and volunteers in American society is often helped at the start by political interest, but evolution of a constructive and stable relationship is probably fostered by the maintenance of appropriate detachment from the volatile political process.

While our analysis has stressed the similarity of social process and the transferability of experience between China and western nations rather than the differences, here is where we encounter the crucial difference affecting the organization of professional-volunteer collaboration. Because all organized aspects of Chinese life are integrated into the political structure, only that political structure is avail-

able as a means for lodging the earthquake prediction effort securely in the community and making the system work as a whole. In our western "multigroup society" (MacIver, 1947), similar community grounding and utilization of broadly based coordinating structures can be achieved through organizations that are not links in the political sector. Thus the benefits in community support for incentive and control, in facilitating recruitment, and in making pre-existing communication networks available that the Chinese achieve by lodging their amateur groups in civil units can be equally well secured, and without the risks from politicization of science, by working through schools, youth programs that involve entire families, and age cohort organizations.

We have been using the term amateur in referring to the Chinese pattern and the term volunteer in referring to the American pattern without examining the difference and similarity of meaning. Stebbins (1977) has described the pattern of *modern amateurism* which has developed in parallel to certain vocations that were formerly exclusively avocations. Sport, entertainment, science, and the arts are the major spheres in which the amateur in this sense plays a significant part. The concept of amateur is more familiar in reference to amateur athletic teams and amateur theatrical groups than to amateur scientific teams, yet the resemblance is illuminating. Some of the Chinese amateur groups fit into this pattern surprisingly well. The amateur has several distinguishing features besides being unpaid and less technically proficient and polished than the professional. Three that we shall stress are the amateur's love of the activity, often valuing it for its intrinsic features even more than the professional, for whom it is a living; the amateur's level of proficiency and understanding of the activity that are well beyond those of the "hobbyist" or "dabbler;" and the fact that the amateur is like the professional in serving a public, and unlike the hobbyist who is performing for himself and selected others. The amateur, then, is much more than

just a volunteer. While amateurs admire and defer to professionals, they perform in their own leagues, patterned after the leagues of the professionals. If we are talking about developing a cadre of volunteers who will develop a certain amount of technical proficiency, sufficient understanding to make reasonable judgments of which observations merit emergency attention and which do not, and the dedication of aficionados, the model of the amateur sportsman and thespian can be helpful.

Stebbins pointed out that the amateur could only be understood as part of a professional–amateur–public system in which each performed certain functions. First, the amateur is like the professional in serving the public. Amateur athletic teams stage events for the enjoyment of spectators; Chinese amateur groups carry out much of the person-to-person and group education for earthquake survival, as well as reporting observations to scientists. Second, the amateur is often able to contribute perspective and even new directions to the field because the circumstances of his activity are less standardized and the cost of unsuccessful experimentation is less. Thus the Chinese amateur groups' improvisation with measures of telluric current, which may turn out to be a blind alley, are nevertheless of interest and potential importance to the scientist. Third, as the amateurs attain sufficient knowledge in the field, they are able to evaluate the performance of professionals and consequently play an important role in maintaining standards of professional performance. Amateurs in integral relations with scientists might reinforce the scientists' attention to the immediately practical concerns of earthquake prediction. And finally, amateur status may be both the stepping stone to a professional career, as the middle school amateur seismologists go on to the university, and the role through which former professionals continue to utilize their skills.

Clearly when we think of an integrated team of professionals and amateurs we evoke a rather different picture than when we think of a call

for volunteers to relieve physicians or nurses from some of the more menial aspects of their work. But we also describe a pattern which has highly significant parallels in American amateurism and the more stable segments of the Chinese amateur–professional system. It also seems apparent that many of the difficulties characteristically associated with the use of volunteers in the United States are less significant when we envision an integrated professional–amateur–public social system.

Assuming that units of the scientific establishment are willing to try out a collaborative relationship of this kind, two problems must still be resolved if a stable system is to be evolved. First, the arrangement must take account of the interval of years and even decades that will usually intervene between the onset of amateur observation and the payoff in prediction of a significant earthquake. The amateur activities Stebbins is describing lead to fairly frequent events before audiences. The experience with climatological observers indicates that sustained cooperation may be secured without dramatic payoff. But at least the contribution of climatological records to daily weather forecasts gives the activity meaning that may be harder to find in daily reports for an earthquake prediction that is never issued. There are at least two approaches to dealing with this problem.

One approach is to recruit amateurs as apprentices on an explicitly temporary basis. The amateur role becomes part of a learning experience which calls for intense dedication for from one to a few years, with planned rotation out of the role by the time that the learning opportunities from the role have been exhausted. One important advantage of working through schools and youth organizations is that interested participation can be programmed along with provisions for a succession of amateurs. The more advanced amateurs in such an arrangement can play a large part in training and supervising the novices, and can assume major responsibility for the filtering of

emergency communications.

The other approach is to incorporate earthquake prediction into a multi-purpose activity that is sustained by the several functions it performs in the amateurs' lives. This proposal is similar to the recommendation by Fritz (1960) concerning a national fallout shelter program, namely, "Every effort should be made to incorporate multiple peacetime uses into shelter construction, so that the shelter is not viewed simply as a place of refuge in the event of attack but as a place that has value in current life" (p. 144). The Four-H Club member who keeps daily records of his animals' behavior should do so in a program under which earthquake prediction is but one of several uses for the observations.

The second problem arises from what may be discrepant goals between professionals and amateurs. R. Popkin (personal communication) observed that in a U.S. Geological Survey conference on the use of volunteers in earthquake prediction (Menlo Park, February 2 and 3, 1978) the agency representatives came inspired to join in a life-saving earthquake prediction enterprise but were offered principally the opportunity to contribute to a long-term research program. There is a volunteer mystique that casts the volunteer in an unrealistically heroic role, and produces a disposition to believe that uneducated peasants single-handedly predicted Chinese earthquakes. Nevertheless the prospect of contributing to the prediction of an earthquake with consequent saving of lives will undoubtedly be a paramount incentive even for sophisticated amateurs. The scientist's career rests more on the long-term record of research than the chancy prediction of a single earthquake. The maintenance of sufficient mutuality to produce a stable working system between professionals and amateurs will require that communication systems be geared to predicting earthquakes as well as conducting research. The provision for detecting and forwarding reports of potentially critical observations and for amateur participation in the filtering of these

reports and briefings on the nature and grounds for final decisions are the minimal requirements for accommodating amateur goals.

CONCLUSIONS

The major theme of our discussion has been the transferability of insights concerning the use of volunteers in such science-related activities as earthquake prediction between the People's Republic of China and the United States and other western nations. In spite of recurrent problems, the penchant for sustained volunteer service in a worthy program is high in the United States. Contrary to journalistic characterizations of a "people's war against earthquakes," the Chinese program is a far cry from the unregulated grass-roots movement often feared by western scientists. Although the dynamics of the Chinese program have not yet been exposed to searching social science investigation, the organization and procedures are well — though not perfectly — designed to deal with the problems of recruitment, incentive, control, and communication in the special forms they take in the use of volunteers in an earthquake prediction program. In most instances the Chinese solutions can be adapted to the nature of western societies in developing a model for use in the west.

At least five features of the Chinese program merit serious consideration in devising a plan for the United States.

(1) The organization of the program around *amateurs* rather than mere volunteers. The example of recruiting from established groups of sophisticated amateur astronomers in the Moonwatch program or of the Chinese middle school student who has learned enough to be able to try out different ways of measuring telluric current is more suitable than that of a collection of novices filling their free time by blindly following instructions from scientists.

(2) The organization of the amateur experience as an apprenticeship, designed to foster personal growth and in some instances to serve

as a stepping stone toward a vocation.

(3) The integration of the amateur activity into already established broadly-based organizations rather than the creation of a new and independent organization. Rather than broadcasting an appeal to the public to establish or join groups that report strictly to the local seismic station, the Chinese ask that groups be established in communes, factory committees, and schools.

(4) Incentive, control, and communication are all facilitated by the maintenance of dual lines of authority and communication, so that amateurs communicate both with the sponsoring unit and with the seismic specialists.

(5) And finally, the Chinese practice of using participatory filtering units in order to select those reports that should be forwarded on an emergency basis for prompt study by the professionals is crucial in resolving the problem of communication overload while strengthening both incentive and control.

On the other hand there are important contrasts in the way an amateur program can be most effectively designed for the United States.

(1) The Chinese make political motives paramount in recruiting and sustaining amateur participation. American experience has shown that political or national concerns can be powerful incentives in periods of crisis, but that the service-interest—personal development motivation complex is quite adequate and probably more dependable as the incentive for volunteer and amateur participation in useful programs.

(2) While the Chinese work through the local civil units in establishing their amateur network, autonomous and semi-autonomous organizational sectors in American society constitute a more appropriate medium.

(3) While the Chinese program is chiefly crisis-oriented, an American program will, at least for the present, have to be organized on the basis of more sustained and less crisis-motivated activity. The critical contributions of China's amateur groups come after intermediate-

and short-term predictions have been issued. No doubt the report of an anomaly such as the southern California Uplift in February, 1976, would create the incentive for crisis observation. But the long period without an earthquake and the intermittent and conflicting reports on its significance might render any such motivation quite unstable. Until American scientists are confident that they can issue reasonably reliable intermediate- and short-term predictions in time to organize crisis-observation groups, the need is rather for sustained observation and disciplined record keeping.

(4) Finally, the Chinese plan conceives of earthquake amateur groups as single-purpose units. Since it will be difficult for people to feel deeply the importance of years of record-keeping without a significant earthquake, an amateur program is more likely to be effective if the earthquake-prediction observations are combined with other meaningful activities. Thus multiple-purpose activity is more likely to be effective than the single-purpose Chinese pattern.

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