# Spatial diffusion

*Diffusion* is as well the *action* as the result of action to spread, or to transmit and propagate in a uniform way. It is thus expressed by all moves which, whatever their driving force, are trying to spread something in a system in an homogeneous way, thus tending to bring it from one equilibrium state to another equilibrium state when, under certain conditions, the system is saturated because its absorbing potential is exhausted. The notion of diffusion, considered from the action standpoint, is introduced when it comes to study processes which involve moves of matter, of products, of persons, of practices, or of ideas in a whole. The notion of *spatial diffusion* covers all processes that contribute to moves, to migration inside geographical space, and to backlash effects generated in this space by those moves. Diffusion may be linked with a migration move accompanied by re-location or to an expansion move.

Is it possible to assimilate any move in space to diffusion? It is generally considered that assimilation is acceptable if the move ends up into a form of colonisation, into a settlement, into installation of something new which is complex enough to make its integrative power predictable at different geographical scales.

A nomothetic approach of spatial diffusion is effectively introduced in geography by T. HÃ¤gerstrand (1952) who, on basis of several case studies, emphasises existence of temporal and spatial regularities in the processes of spatial diffusion of innovation. The expression of these regularities has opened a way for their modelisation, and relaunched reflection on their role in dynamics of geographical spaces.

Necessary conditions for spatial diffusion of an innovation to happen have thereby been identified :

- birth in some place of an innovation able to travel and to impose itself as such
- ability of place of birth of innovation to become an emitting source
- existence of a receiving environment which fosters a quick propagation
- *propagation* force important enough and propagation time long enough to make interruption of the diffusion process hardly probable.

Spatial diffusion favours some propagation channels. It works in a large extent through contagion in the neighbourhood : probabilities of contact between emitters and receivers of innovation rapidly decreasing in function of distance. It is particularly sensitive to the hierarchical structure of settlement systems, the new phenomenon tends to appear going down the scale of urban hierarchy. Furthermore, and for the same reasons, the bigger the emitting centre, the higher its force of impulse in the diffusion process, hence the descending course of diffusion of a very large number of innovations in urban networks. Conversely, processes of spatial diffusion of innovations are slowed down, deviated and sometimes stopped by *spatial* barriers. Finally, a same process of spatial diffusion is most of the time multi-scalar, and in this case, the interplay of interactions guiding diffusion is changing from one geographical level to another.

The temporal framing of spatial diffusion follows a number of rules. The *primary step* of the process corresponds to the beginning of diffusion. At this stage, diffusion introduces a new differentiation inside geographical space, a contrast is appearing between places that have adopted the innovation and other places. The *expansion step* is the period of actual development of the process, which generates a gradual softening of the strongest contrasts between places. During the next step, called *condensation step*, the rate of penetration into the different places tends to become more homogeneous, while speeds of diffusion in the various places grow closer. In the ultimate step of the process, called *saturation step*, the penetration rate increases toward a maximum following an asymptotic curve.

The apparent instantaneousness of propagation, allowed by new techniques of information diffusion, sometimes enforces the idea that spatio-temporal gaps in diffusion would have lost all significance. Whereas for a large number of innovations, those new techniques have probably reduced frictions of time and distance affecting information transmission, the structures of receiving geographical space are maintaining significant differentials in matter of response delays that convert received information into adopted innovation.

In the field of social sciences, the notion of diffusion is often associated with that of innovation. To innovate is to introduce into an established thing something new, still unknown, which is likely to transform it. Innovation cannot be dissociated from diffusion. Irreducible to invention or fashion, it is, according to Schumpeter (1934), the combination of new things that, propagating in an *environment*, generate irreversibilities in evolution of this environment. The more complex the diffused innovation, the more influence its diffusion process will have on transformation of its propagation environment, as effects induced by its adoption will be all the more increased.

Processes of spatial diffusion of innovations may be modelled. Many attempts have been made in this view in particular by geographers, epidemiologists, demographists and botanists.

A logistic function, which describes growth of a population in a space with limited resources, is commonly used to model development of the process in time, whereas the number of potential adopters represents the resource limiting expansion of diffusion. The four main stages of the diffusion process may be identified on the curve that represents this function.

Modelling spatial dimension of the diffusion process involves basic principles implemented in spatial interaction models (effect of masses, and of distance, barrier effects, etc..), which quite often take the form of an exponential function of distance with a negative exponent. The process time being split into discrete units, at each time unit, spatial interaction rules introduced into the model allow defining in any place probabilities of contact between emitter and receiver and thus probabilities of local propagation (contact field expressed in the form of a probabilities grid). Many refinements have been devised to take notably local conditions of propagation into account, besides general conditions that are supposed to be rendered by the contact field. T.HÃ¤gerstrand (1953) had recommended using Monte Carlo method in order to simulate spatial propagation across time as a random process. Computer methods for modelling seem able to significantly widen the range of potentialities for geographic prediction of a diffusion.

see also: Nomothetism

## Bibliographie