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以下三題請詳讀題目後說明：(1)題目之主要重點及(2)該題在資源管理之意涵。

(資料來源：Tom Tietenberg and Lynne Lewis(2015), *Environmental & Natural Resource Economics*, 10th Edition, Pearson Global Edition.)

一、(30%)

Located on an island 75 miles off the coast of Copenhagen, the city of Kalundborg has achieved a remarkable symbiosis among the various industries that provide the employment base for the city. The four main industries, along with small businesses and the municipal government, began developing cooperative relationships in the 1970s designed to lower disposal costs, attain less expensive input materials, and receive income from their waste products.

A coal-fired power plant (Asnaes) transports its residual steam to a refinery (Statoil). In exchange, Statoil gives Asnaes refinery gas that Asnaes burns to generate electricity. Asnaes sells excess steam to a local fish farm, to a heating system for the city, and to a pharmaceuticals and enzyme producer (Novo Nordisk). Continuing the cycle, the fish farm and Novo Nordisk send their sludge to farms to be used as fertilizer. Produced fly ash is sold to a cement plant and gypsum produced by its desulfurization process is sold to a wallboard manufacturer. Statoil, the refinery, sells the sulfur removed from its natural gas to a sulfuric acid manufacturer, Kemira.

This entire process resulted not from centralized planning, but simply because it was in the individual best interests of the public and private entities involved. Although the motives were purely financial, this synergetic situation has clear environmental benefits. It is therefore likely to be economically, as well as environmentally, sustainable.

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二、(35%)

Both forests and soils sequester (store) a significant amount of carbon. Research suggests that with appropriate changes in practices, they could store much more. Increased *carbon sequestration* in turn would mean less carbon in the atmosphere. Recognition of this potential has created a strong push in the climate change negotiations to give credit in carbon markets or toward carbon taxes for actions that result in more carbon uptake by soils and forests. Whether this should be allowed, and, if so, how it would be done are currently heavily debated.

Proponents argue that this form of carbon sequestration is typically quite cost-effective. Cost-effectiveness not only implies that the given goal can be achieved at lower cost, but also it may increase the willingness to accept more stringent goals with closer deadlines. Allowing credit for carbon absorption may also add economic value to sustainable practices (such as limiting deforestation or preventing soil erosion), thereby providing additional incentives for those practices. Proponents further point out that many of the prime beneficiaries of this increase in value would be the poorest people in the poorest countries.

Opponents say that our knowledge of the science of carbon sequestration in the terrestrial biosphere is in its infancy, so the amount of credit that should be granted is not at all clear. Obtaining estimates of the amount of carbon sequestered could be both expensive (if done right) and subject to considerable uncertainty. Because carbon absorption could be easily reversed at any time (by cutting down trees or changing agricultural practices), continual monitoring and enforcement would be required, adding even more cost. Even in carefully enforced systems, the sequestration is likely to be temporary (even the carbon in completely preserved forests, for example, may ultimately be released into the atmosphere by decay). And finally, the practices that may be encouraged by crediting sequestration will not necessarily be desirable, as when slow-growing old-growth forests are cut down and replaced with fast-growing plantation forests in order to increase the amount of carbon uptake.

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三、(35%)

One of the threats to sustainable development is the growing number of vehicles on the road. Though great progress has been made since the 1970s in limiting the pollution each vehicle emits per mile of travel, as the number of vehicles and the number of miles increase, the resulting increases in pollution offset much of the gains from the cleaner vehicles.

How to limit the number of vehicles? One strategy that started in Europe and has migrated to America is car-sharing. Car-sharing recognizes that the typical automobile sits idle most of the time, a classic case of excess capacity. (Studies in Germany suggest the average vehicle use per day is 1 hour.) Therefore the car-sharing strategy tries to spread ownership of a vehicle over several owners who share both the cost and the use.

The charges imposed by car-sharing clubs typically involve an upfront access fee plus fees based both on time of actual use and mileage. (Use during the peak periods usually costs more.) Some car-sharing clubs offer touch-tone automated booking, 24-hour dispatchers, and such amenities as child-safety seats, bike racks, and roof carriers.

Swiss and German clubs started in the late 1980s. As of 1998, an estimated 25,000 Germans and 20,000 Swiss belonged to car-sharing groups. The European idea of car-sharing was captured by some US entrepreneurs who started Zipcar, a company that now boasts 400,000 members and fleets of car-sharing vehicles in 50 cities in North America and the United Kingdom. Similar car-sharing companies can now be found in hundreds of cities.

The University of California, Berkeley's Transportation Sustainability Research Center (TSRC) and Susan Shaheen have been tracking car-sharing developments worldwide since 1997. They report that as of January 1, 2013, there were 46 active programs in North America with 1,033,564 members sharing 15,603 vehicles.

What could the contribution of car-sharing be to air pollution control in those areas where it catches on? It probably does lower the number of vehicles and the resulting congestion. Zipcar claims that each Zipcar takes 15-20 personally owned vehicles off the road. In addition, peak-hour pricing probably encourages use at the less polluted periods. On the other hand, it does not necessarily lower the number of miles driven, which is one of the keys to lowering pollution. The contribution of this particular innovation remains to be clarified by some solid empirical research.