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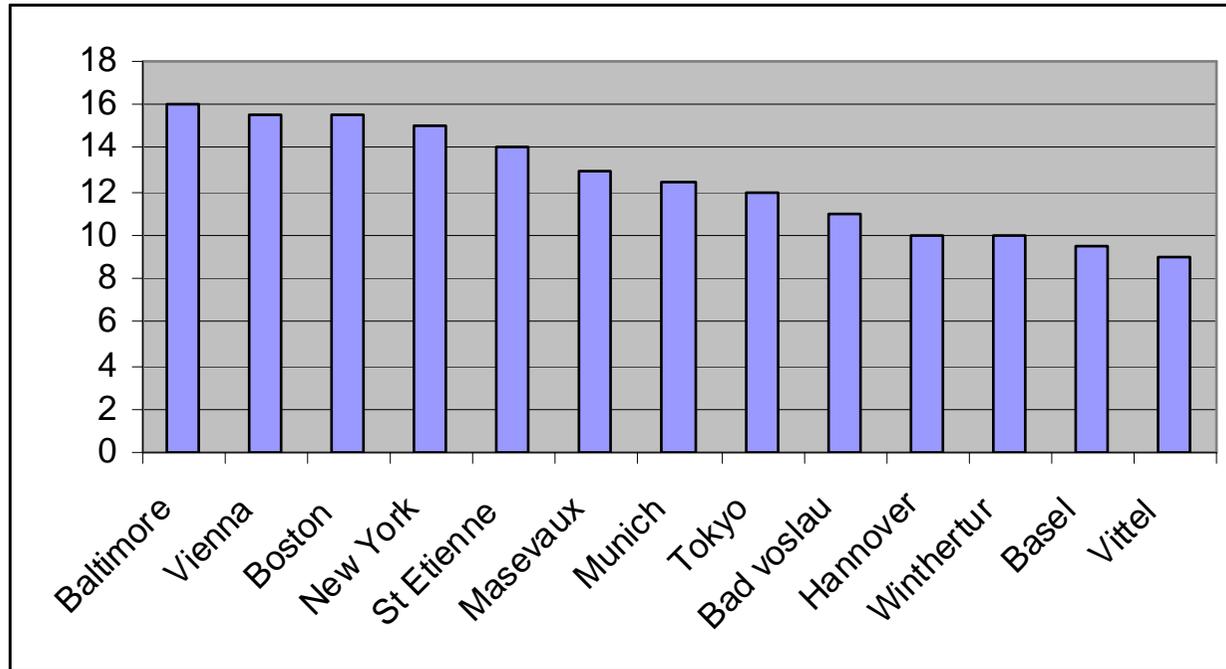
Appendix 1: Comparison table of the sites

| Grading | Site/Town | Type of catchment | Number of m3/day | Total area of the watershed | Area of the protected zone of the watershed | Percentage of forest cover | Type of action | Forest management peculiarity |
|----------------|------------------|----------------------------------------------------------------------------------------------------------------------|-----------------------------|--------------------------------------------------------------------|---------------------------------------------------------|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| | Basel | 0,9 M m3 come from streams; 27,6 M m3 come from re-pumping of the water table (comes initially from the Rhine river) | 75000 m3/day (206000 inhab) | | | water is totally filtered by forest | ? | water from the Rhine river is pumped and seeped into a 22 ha forest to be filtered (Lange Erlen site) and pumped again when it arrives in the water table |
| without weight | 11 | 2 | 2 | | 1 | 4 | 1 | 1 |
| with weight | 9,5 | 2 | 1 | | 0,5 | 4 | 1 | 1 |
| | Baltimore | catchments of rivers/streams (reservoir) | 5 million pers | 115 000 ha | 10% is protected, of which 7100 ha belongs to Baltimore | ? | land acquisition, contracts with landowners, tax credits, conservation easement | restoration of riparian zones, forest mgt around reservoirs, watershed partnership, BMP evaluation, conservation and management models |
| without weight | 20 | 3 | 4 | 4 | | 2 | 4 | 3 |
| with weight | 16 | 3 | 2 | 2 | | 2 | 4 | 3 |
| | Boston | catchments of rivers/streams (reservoir) | 600000 m3/day | ~48000 ha (of which 22000 ha controlled by the waterworks company) | | 87 % forest, 6 % wetlands | land acquisition, payments in lieu of taxes, land disposition, conservation restrictions, technical assistance to communities and private land owners, public education | species diversification, uneven aged forest, limited forest cut, importance of forest regeneration |
| without weight | 18 | 3 | 3 | 2 | | 4 | 3 | 3 |
| with weight | 15,5 | 3 | 1,5 | 1 | | 4 | 3 | 3 |

| | | | | | | | | |
|----------------|------------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------|------------------------------------------------------------------------------|-------------------------------------------------------------------|----------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | Hanover | 110 wells | 137000 m3/day (500000 inhab) | 85% of water come from Fuhrberg Feld - 30000 ha | | 50% forest | land acquisition | broadleaved tree plantation, continuous forest cover |
| without weight | 12 | 2 | 2 | 2 | | 2 | 1 | 3 |
| with weight | 10 | 2 | 1 | 1 | | 2 | 1 | 3 |
| | Masevaux (France) | 10 shallow catchments (3 to 4m) | 700 m3/day (5000 inhabitants) | | all the protection zones in Masevaux forest - 1250 ha | 100% | the forest belongs to the commune of Masevaux - particular management by the State forest agency | better communication between forest managers and water works services, attention to harvesting operations, improvement of forest roads, consciousness-raising of hunters |
| without weight | 14 | 4 | 1 | | 1 | 4 | 1 | 3 |
| with weight | 13 | 4 | 0,5 | | 0,5 | 4 | 1 | 3 |
| | Munich | deep water extraction, catchment of surface streams, catchments of shallow water | 411000 m3/day (500000 inhab.) | | 6000 ha | almost 50% (2900 ha of forest on 6000 ha) | land acquisition, contracts with farmers for organic farming conversion | Uneven-aged forest, limiting pollution sources, harvesting operations in winter |
| without weight | 15 | 3 | 3 | | 2 | 2 | 2 | 3 |
| with weight | 12,5 | 3 | 1,5 | | 1 | 2 | 2 | 3 |
| | New York | catchments of rivers/streams (reservoir) | 5 M m3/day (9 M inhab) | 99 % of water come from Catskill/Delawar e warershed - 414000 ha | | 3/4 of forest | land acquisition, conservation easements, buffer strip forest and wetlands management, farming program, education/information of foresters and loggers, public information, sewage treatment | help/incentive for forest owners to have forest management plans, "Best management practises" development, education/information, research |
| without weight | 19 | 3 | 4 | 4 | | 3 | 3 | 2 |
| with weight | 15 | 3 | 2 | 2 | | 3 | 3 | 2 |

| | | | | | | | | |
|----------------|---------------------------------|----------------------------------------------------------------------|----------------------------------|----------|-------------------------------------------------------------------|-----------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | St Etienne (France) | superficial/shallow catchments (1,80 to 2m), filtering soil | 29000 m3/day (60000 inhabitants) | 2500 ha | 1200 ha | 100% for the catchment zone (75% for the total watershed) | land acquisition, contract with the waterworks company, education | Uneven-aged forest, importance of broadleaved trees, clearing just above the drainage pipes, forbidden for harvesting machines to pass over water pipes |
| without weight | 15 | 4 | 1 | 1 | | 4 | 2 | 3 |
| with weight | 14 | 4 | 0,5 | 0,5 | | 4 | 2 | 3 |
| | Tokyo | catchments of rivers/streams (reservoir) | 7 M m3/day (27 M inhab) ? | 48000 ha | | 100 % forest (of which 44 % belonging to Japanese State) | particular forest management only in forest belonging to the State | forest is said to be "well managed for drinking water purposes", but nothing in private forest (only "Tamagawa suigen shintai" where volunteers come to do plantations/thinning operations) + actions against game |
| without weight | 15 | 3 | 4 | 2 | | 4 | 1 | 1 |
| with weight | 12 | 3 | 2 | 1 | | 4 | 1 | 1 |
| | Vienna | almost all water comes from the catchment of 2 streams, karstic area | 400000 m3/day (1,78 M inhab.) | | 90000 ha | 2/3 of forest (of which 32000 ha belonging to Vienna) | land acquisition, 2 decrees to restrict some practises for private owners, research | Uneven-aged forest, "natural forest", hydrotope model, continuous forest cover, cable yarding, limitation of pollution sources |
| without weight | 19 | 4 | 3 | | 4 | 3 | 1 | 4 |
| with weight | 15,5 | 4 | 1,5 | | 2 | 3 | 1 | 4 |
| | Vittel (France) | deep wells, soil sensitive to pollution (limestone) | ? | 5000 ha | | 11 % (half public forest, half private - Nestlé) | land acquisition and tenant farming with farmers | Uneven-aged forest, dynamic underlayer vegetation |
| without weight | 10 | 2 | 1 | 1 | | 1 | 2 | 3 |
| with weight | 9 | 2 | 0,5 | 0,5 | | 1 | 2 | 3 |
| | Winterthur (Switzerland) | water comes from water table | 23000 m3/day (90000 inhab) | | 100 ha in protection zone (belongs to the 1900 ha of the commune) | probably 100 % forest | land acquisition, and if possible land exchange with private owners | reforestation, biodegradable oils, dynamic forest underlayer, organic farming |
| without weight | 11 | 1 | 1 | | 1 | 4 | 1 | 3 |
| with weight | 10 | 1 | 0,5 | | 0,5 | 4 | 1 | 3 |

Results: classification of the « most interesting » sites for my study



Appendix 2: Questionnaire for the inventoried sites

1. Presentation of the situation

Area of the total watershed, area of the protected zone of the watershed, percentage of forest cover over the watershed, number of people relying on drinking water from this watershed, number of m³, price of water

2. Type of action

Scientific research, land acquisition, contracts with forest owners/farmers, regulation, information of public, education, schemes of payment of environmental services...

3. Management implemented for the protection of drinking water

When did the action plan begin? Who gave the impulse ?

3.1 Particularities of the forest management over all the watershed area

Tree species composition, silvicultural treatment (even aged or uneven aged stands, clear cut regulation, type of regeneration...), harvested volume per cut, regulation/restrictions for harvesting, use of chemical products/ pesticides...

3.2 Particularities of the forest management just around the water catchments points (above the water pipes)

Same as above

3.3 Forest road network

Density, particular measures to prevent from erosion or surface water streaming

3.4 Hunting and recreation management

Any particular measure or problem?

3.5 Pasture land or agricultural land management

Any particular measure or problem?

4. Forest situation

4.1 Forest characteristics

Geologic situation, main types of soils

Topographic situation

Ecological type, natural forest communities

Actual situation (species composition, type of forest stand, volume, annual increment...)

4.2 Forest management

Actual management, articulation between forest management plans and watershed management plan (if they are different)

4.3 Ownership

Percentage of public or private owners

5. Relationships between the actors / stakeholders

Relationships with private forest owners?

Problems or conflicts?

Others actors/ stakeholders?

Relationships with research organisms?

6. Costs

Estimation of the cost (or extra-cost) linked to this drinking water objective in the forest management?
How is it financed?

7. Evaluation of the action plan

Evaluation of the water quality: monitoring before/after implementation of the watershed action plan?

Further water treatment (chlorination,...) ?

Global evaluation of the action plan, improvements in the future?

8. References

Appendix 3: Filled questionnaires of the inventoried sites

1. Basel

1. Presentation of the situation

Basel drinking water supply is organised by the public company Industrielle Werke Basel (IWB).

The water supply system is rather original: water from the Rhine River is pumped and seeped into a forest to be filtered and pumped again when it arrives in the water table. Infiltration is made in 2 forests: Lange Erlen (22 ha) and Muttенzer Hard (208 ha) where infiltration is done in trenches and small lakes.

Annually 27.6 M m³ come from re-pumping of the water table in Lange Erlen and Muttенzer Hard (comes initially from the Rhine river). 75, 000 m³ of drinking water are delivered each day to Basel inhabitants.

The price of water for Basel consumer is 1. 40 CHF/ m³.

2. Type of action

IWB owns the forest lands where water is filtered but forest harvesting is realised by private companies.

Three farmers are present in the forest areas. Their farming plan is done in co-operation with IWB to be sure that their activities will not degrade water quality. They do not receive financial compensation but the price they pay to rent the land is very low.

3. Management implemented for the protection of drinking water

This water supply system from the Rhine River began in 1963. Before, water was pumped from another river, the Wiese, and the infiltration process was less structured.

3.1 Description of infiltration process in Lange Erlen

Water is pumped from the Rhine, 2 km away from Lange Erlen forest.

The infiltration areas are separated in 3 zones. For a period of ten days, the first area will be flushed with pre-filtered water from the river Rhine. After these ten days the infiltration will be held in the second area; and after another 10 days, in the third area. In this case, after the infiltration each area will stay 20 day's without infiltration of water. During these 20 days the ground will be regenerated by itself.

The filtering is realised in the forest soil: humus + 2-3 m of sand and gravels that guarantee a mechanical, chemical and biologic purification of water. Micro-organisms of the soil play a very important role. As they need Oxygen, each infiltration zone has to be let dry during 20 days.

In all this area and in farming lands, the use of pesticides is not allowed.

Water quality is monitored at different points (in the Rhine, before the infiltration, after the infiltration, after final treatments). After the filtration in forest, water is treated to active coals and chlorinated. A degassing is also done.

3.2 Natural site characteristics

The soil lies on Rhine alluviums.

Topography is « soft » (small hills).

The precipitation in 2007 was 931.1 mm (788 mm between 1961 and 1990). The average temperature in 2007 was 11.32 °C (9.74°C between 1961 and 1990).

3.3 Management applied in forest

Forests are composed of beech (26%), ash (20%), maple (12%) and oak.

The main forest function is water protection. Wood production and recreation are limited to preserve soils.

Harvest techniques are diverse: chainsaw, harvester, extraction by tractor.

Biologic oils are recommended.

3.4 Particular forest management in infiltration zones

Forests are composed of oak, hornbeam, alder, willow, cherry, ash and black poplar.

Before, there were a lot of hybrid poplars.

Infiltration areas are fenced to prevent from dogs faeces.

Wood production is not an objective in this zone. Forest works are done manually.

3.5 Hunting and recreation

Hunting is not allowed.

The 2 forests are important recreation areas. Littering is a major problem.

4. Cost

The costs of forest management are around CHF 100, 000 per year. There are adding costs for maintenance of the paths, green maintenance, littering removal. The costs therefore are around CHF 200, 000 per year, which represents CHF 0.011/ m³.

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5. Evaluation of the action plan

In the next future, depending on the Rhine water quality, other water treatment processes will be discussed.

6. References

Thomas Meier (IWB) thomas.meier@iwb.ch

JORDI (B.).- Le sol forestier : un filtre idéal-3. *Environnement* 3/05 Forêt, p. 32 to 35

2. Baltimore

1. Presentation of the situation

Maryland covers 2, 500, 000 ha, of which 20 % are protected from any development. 5 million persons live in this State. The population of Baltimore and Washington DC spread around drinking water reservoirs, which threatens this resource.

10 % of the reservoirs watershed areas is protected. The total surface of watersheds is 115, 000 ha. Around 7, 100 ha belongs to Baltimore city.

The forest service department of Maryland has developed a watershed forest management program with USDA and private forest associations.

This program encompasses riparian forests restoration, water reservoirs management, and BMPs evaluation. Others actions are also implemented to protect the watersheds.

2. Types of action

Baltimore city acquired more than 7, 100 ha of land around reservoirs between 1880 and 1955. In 1999, the Maryland DNR Forest service has developed a management plan of these forests (see 3.1).

But these public forests represent only a small part of the watershed. Other actions have therefore been implemented in private forests to protect watersheds.

- 1) Participate in and support emerging ecosystem markets and land registries to generate additional incentive for continued forest conservation and restoration;
- 2) Develop a Sustainable Forestry Policy in Maryland by 2008 to stimulate improved forest conservation through:
 - a) Tax incentives, such as income tax credit for developing a forest stewardship plan and expanded property tax rebate for having a forest stewardship plan;
 - b) Effective and equitable regulations, particularly related to forest harvesting;
 - c) Forest enterprise zones to support healthy forest product markets and technical innovation for new markets;
 - d) Forest health reserve fund to improve response to forest health threats; and
 - e) Family forest revolving loan fund for intact intergenerational transfer of forests;
- 3) Link forests, storm water, and water supply through Comprehensive Plan Elements like Sensitive Areas, Water Resources, and Land Protection Plans, and new requirements for prioritized environmental site design for storm water;
- 4) Revise the Forest Conservation Act to reduce forest loss through development, potentially to no net loss of forest;
- 5) Support full funding annually and bond measures for Maryland's dedicated land conservation funding through Program Open Space, including Rural Legacy and Maryland Agricultural Land Preservation Foundation;
- 6) Adopt a transferable and/or refundable tax credit program for donated conservation easements by 2009;
- 7) Support effective local Transferable and Purchase of Development Rights programs;
- 8) Adopt a watershed improvement benefit district to aid forest conservation and restoration by 2009;
- 9) Invest in coordinated tracking for forest and other vegetative cover by 2008;
- 10) Invest in ongoing education, outreach, and technical assistance to local jurisdictions and landowners to improve forest conservation and management.

3. Management implemented for the protection of drinking water

3.1 Particularities of the forest management over all the watershed area

The protection program implemented by USDA forest service encompasses the following measures.

- **Riparian forests restoration**

Since 1987, 1722 km of riparian buffers have been restored (2,4 % of the whole riparian buffers of Maryland).

The survival rate of seedlings plants there has increased from 60 % in 2000 to 87 % in 2003, thanks to improved maintenance. Natural regeneration is also favoured when it is present.

- **Management of protection forests around reservoirs**

A management has been established in 7, 100 ha of forests belonging to Baltimore, around 3 reservoirs (Loch Raven, Prettyboy and Liberty). The objectives are: protection of water quality, biodiversity and recreation. Forest resilience is the main goal to reach.

Diagnostic pointed out problems of insufficient regeneration, dangerous recreation activities, abusive rivers crossing, forest vulnerability to wind throws.

The management plan includes regeneration protection against game browsing (fences), forest stands evolution to have a better resistance to wind, encouragement of rapid growing species on shallow soils.

The aim, in the long term is to have diverse forest stands in species composition, age and structure (uneven-aged forest). Pine plantations require a different treatment (introduction of deciduous trees).

Invasive species are a major problem, linked to the garden proximity in forest near reservoirs.

Private owners sometime consult DNR forest service to establish management plans. Their objective is not to protect water, but they have to apply BMPs to prevent erosion and sedimentation.

- **Creation of a watershed partnership** to integrate different forest services and provide a network.
- **Evaluation of BMPs** concerning forest harvesting to test their efficiency and generalise them.

In a directive signed by the Chesapeake Executive Council on September 22, 2006, the Governor of Maryland committed state resources to “conserving those forest lands in the Bay watershed where conservation to protect water quality is most needed.” A major part of this commitment is to use the best available tools to locate areas where retention and expansion of forests is most needed to protect water quality and to set a goal, framework, and milestones for protecting forested areas of critical importance to water quality (in acres or percentage of forested lands) while considering which of those are most vulnerable to development.

To assist in setting an achievable goal for forest conservation and to locate those forests with imperative water quality functions, the Maryland DNR Forest Service is developing three geographic information models: a conservation model, a management model, and a restoration model.

Long-term Forest Conservation Goal in Maryland

Maryland’s current forest cover is estimated at 41%. The long-term goal is to retain existing levels of forest cover in the state and expand it in areas of higher benefit for water quality, habitat, and rural economies.

1. Extent Matters: Retain existing levels of forest cover in Maryland, estimated at 2.6 million acres.
2. Location Matters: Protect 20% of Maryland (1.25 million acres) in forest cover, targeting areas with high value for water quality, conserving and expanding forests located in areas such as stream and shoreline buffers, wetlands, and steep slopes.

3. Streams Matter: Protect 70% of stream and shoreline buffers from development long-term (35-ft minimum, preferably 100 feet).
4. Context Matters: Develop guidelines to retain at least 65-70% of watershed area in rural land uses, with forest targets based on landscape characteristics like steep slopes, buffers, wetlands, existing and planned developed areas, and prime agricultural soils.
5. Communities Matter: Set urban canopy cover goals in Maryland's municipalities and urbanized areas, focusing on areas developed before storm water management requirements.

2020 Forest Conservation Goal in Maryland

Maryland is committing to time-specific numeric goals and milestones that work aggressively towards the long-term desired conditions and functions.

1. Retain existing levels of forest cover in Maryland, estimated at 2.6 million acres past 2020.
2. Protect an additional 250,000 acres of forest by 2020 through legal mechanisms, with more than half in areas of high value to water quality.
3. Restore an additional 25,000 acres of forest buffers, or other areas of high value to water quality outside of prime agricultural land, by 2020.
4. Produce rural and forest land retention guidelines based on watershed indicators by 2008 that can support requirements for forest and water protection in local comprehensive plans.
5. By 2020, have urban canopy goals for 50% of the area developed primarily before storm water management regulations (pre-1984).

3.2 Particularities of the forest management just around the water catchments points

These zones correspond to riparian forests which are described above.

3.3 Forest road network

The reservoir lands contain 340 km of internal low-volume roads (covering 7 100 ha).

Drainage problems were identified along the majority of the road system, with many of the stream culverts rated as in poor condition, stream fords with silt substrates, and bridges that were unsafe or missing.

3.4 Hunting and recreation management

Despite of hunting, there are problems linked to game browsing.

Forest is an important recreation area (mountain biking, hiking, horse riding, sailing, bird watching).

3.5 Pasture land or agricultural land management

There are many farms lands on the watershed. Conservation easements are signed with farmers.

4. Forest situation

4.1 Forest characteristics

The total watershed area is 115 000 ha. 36 % are forested, 46 % are farm land, less than 1 % are wetlands and 18 % are urban areas. The forest lands owned and managed by the City of Baltimore are separated in three separate patches. Each of the forest patches completely surrounds the associated reservoir within a landscape matrix of forest, agriculture and urban land uses.

Soils are well drained.

Elevation varies from 30 to 275 m.

Annual precipitation is 1, 035 mm. Annual temperature is 12.8 °C.

Main species are chestnut oak (*Quercus prinus*) and scarlet oak (*Quercus coccinea*); the slope type, in which scarlet oak, black oak (*Quercus velutina*) and white oak (*Quercus alba*) at the higher elevations transition down to red oak (*Quercus rubra*), tulip poplar (*Liriodendron tulipifera*) and hickory (*Carya ovata*) on the lower slopes. The bottom type consists mainly of red maple (*Acer rubrum*), green ash (*Fraxinus spp.*), elm (*Ulmus spp.*), birch (*Betula spp.*) and sycamore (*Platanus occidentalis*).

4.2 Forest management

Baltimore forest objectives are :

- water quality protection,
- conservation and restoration of biodiversity around reservoirs,
- forest management to optimise forest habitats,
- public recreation.

4.3 Ownership

7, 000 ha among 115, 000 ha of watershed belong to Baltimore (6 %).

5. Evaluation of the action plan

Water from reservoirs is filtered and chlorinated.

6. References

contact : Anne Hairston-Strang from Maryland DNR Forest Service astrang@dnr.state.md.us

Web page of Maryland DNR Forest Service, conservation goals

HAIRSTRONG-STRANG (A.).- *Cooperative forest watershed management in Maryland : watershed restoration across land ownership*

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3. Boston

1. Presentation of the situation

The Quabbin Reservoir Watersheds supplies each day 600, 000 m³ of drinking water to the 2.2 million inhabitants of Boston region.

Water comes from rivers and is « stored » in huge open air reservoirs.

The « watershed » area is 48, 000 ha (= surface of reservoirs, rivers, with a buffer of 120 m around them). The Division of water supply protection (DWSP) owns 57 % of this zone (10, 000 ha of reservoirs + 22, 000 ha of land). 18 % of additional surface is protected by other agencies.

The watershed is forested to 87 % and has 6 % of wetlands.

Price of water is around 1\$/ m³.

2. Types of action

- Land acquisition: Boston city owns 22, 000 ha and still wants to acquire land.
- Payments In-Lieu of Taxes (PILOT) : DWSP provides financial compensation to cities that own land situated in the protection. Money comes from a tax paid by water consumer. DWSP has no control on the use of these PILOTs, but has to pay them to compensate cities from the loss of revenue caused by the conversion of private to public lands.
- Land disposition: when private or public owners have an incompatible uses of their land with water protection, juridical tools exist to allow DWSP to buy these lands.
- Conservation easement: DWSP has signed 10 conservation easements on the watershed (300 ha) with private owners (purchase of development rights).
- Technical assistance to communities: DWSP provides assistance to realise growth management planning, master plans, land use studies...
- Technical assistance to private forest owners: DWSP encourages and finances partly private forest management plans.
- Maintenance of boundaries
- Public information and forest surveillance
- Protection against forest fires.

3. Management implemented for the protection of drinking water

The watershed is managed since 1961. The last management plan dates from 2007 and will last 10 years. It concerns the 22, 000 ha belonging to DWSP (of which 4 800 ha are not managed).

3.1 Particularities of the forest management over all the watershed area

DWSP has concluded that the forest conditions that best meet the combined objectives of the agency – to deliver predictable quantities of high-quality drinking water at a reasonable cost while protecting the fullest possible suite of associated natural resources – include vigorous trees of broad, site-suited species composition and age classes well-distributed across the watershed and capable of rapid regeneration and active growth following a wide range of both natural and deliberate disturbances.

Up to now, forest stands were even-aged. The objective is to have uneven-aged stands. Managers regenerate 1 % of forest area each year (160 ha/year).

Regeneration is done by little openings (<0,4 ha). If natural regeneration is not enough, plantations can be done.

DWSP also conserves some old stands unmanaged.

Different zones have been created, associated to different limitations of forest harvesting.

Main species are *Pinus strobus* and *Quercus rubra* ; mixed with *Acer rubrum*, *Tsuga*, *Quercus coccinea*, *Betula lenta*, *Quercus alba*, *Fraxinus americana*, *Pinus resinosa*, *Acer saccharum*.

Permanent log landings have to be situated on well drained soils that can carry wood weight.

Equipments prevent water to flow from skid roads to log landings.

Pesticides are not allowed (except under electric lines).

Biologic oils are recommended.

Invasive plants are controlled mechanically or chemically.

3.2 Particularities of the forest management just around the water catchments points

It corresponds to the management applied in the most sensitive zones. Timber harvest is very limited..

3.3 Forest road network

There are around 3.3 km of forest road per hectare (sufficient), mean width of 3 m.

3.4 Hunting and recreation management

Game population is kept under control with hunting.

A park has been created for public recreation on 1 200 ha belonging to DWSP, which represents 2 % of the watershed protection zone. 80 % of recreation is concentrated there.

3.5 Pasture land or agricultural land management

Farmers have to respect the Wetlands Protection Act and the Watershed Protection Act, but there are some exceptions.

4. Forest situation

4.1 Forest characteristics

Elevation varies from 161 to 421 m.

Slopes are not steep (less than 20 %).

Mother rocks have a metamorphic origin.

Soils are well drained, favourable to many tree species (*Quercus rubra*, *Pinus strobus*, *Acer saccharum* and *Fraxinus americana*). There are about 2/3 of deciduous and 1/3 of conifers.

Annual precipitation is 1, 178 mm.

4.2 Forest management

Water protection is the main objective.

4.3 Ownership

22, 000 ha belong to DWSP, 3, 300 ha belong to other governmental agencies.

18, 000 ha (34 %) is privately owned: 7, 000 ha belong to holdings which have a protective management, 11, 000 belong to « small » owners who do not have any restriction.

5. Relationships between the actors / stakeholders

Logging and forest management are very carefully regulated across the entire state by the MA Forest Cutting Practices Act, so DWSP seldom has any conflicts about private land forestry. There are minor problems with agriculture, e.g. when animals are allowed to pasture in wetlands and streams that are tributaries to our reservoirs, but most of these are corrected by the Wetlands Protection Act. The

biggest conflicts are with land developers who desire to convert privately-owned watershed forests into housing developments; DWSP is supported by the Watershed Protection Act, which limits development within 120 m of our tributaries.

DWSP has very strong relationships with the local universities, including the University of Massachusetts, Mt Holyoke College, the Harvard Forest (a research facility of Harvard University that is located within the Quabbin Reservoir watershed), the USDA Forest Service in Amherst, MA and Durham, NH, the USGS, and several smaller associations. DWSP allows research permits through a formal review process and also provide limited funds to pay researchers to answer its own questions.

6. Costs

The annual operating budget for the DWSP is currently \$14 million. On top of that, annual PILOT payments are approximately \$5 million and we are also currently spending approximately \$7 million annually to purchase additional lands. The water from this system is valued at \$100 million annually, and forest management practices provide revenue of \$500,000 to \$1 million annually. DWSP budget is provided to us by the Massachusetts Water Resources Authority, a separate, non-governmental authority that is responsible for the actual delivery of the water to the consumers, after it leaves watersheds.

7. Evaluation of the action plan

Quabbin water quality has been consistently extremely good throughout the life of the system. The revised forest management practices are expected to reduce the likelihood of short-term water quality changes resulting from catastrophic storms or other natural disturbances.

While water is not filtered, measured doses of chlorine are added to disinfect the water as it enters the aqueduct, and chloramines are added to continue to protect the water as it is carried through the aqueduct. In addition, the John J. Carroll Plant, located closer to Boston uses ozone as a primary disinfectant and chloramines for residual disinfection, allowing MWRA to meet current and tougher future state and federal water quality standards. The plant has the capacity to treat up to 1.5 million m³ of water from the Quabbin/Wachusett Reservoirs each day, though 1 million m³ per day is the average. Treated water is held in covered storage along the line, to protect its quality.

DWSP managers are constantly looking to improve. While basic watershed management program seems to be working well, they are trying to address several problems:

- the impact of waterfowl, and in particular gulls and geese, on our bacteria counts
- the impact of a new and rapidly growing moose population on our forest cover
- the effects of expanding populations of invasive plants on our forest cover
- the projected effects of climate change on our species composition and other dynamics
- the pressure of residential and commercial developments throughout our watersheds
- increased recreational pressures on our properties, including mountain biking, horseback riding, and all-terrain vehicles ridden for recreation.

8. References

MASSACHUSETTS DEPARTMENT OF CONSERVATION AND RECREATION? DIVISION OF WATER SUPPLY, OFFICE OF WATERSHED MANAGEMENT.- *Quabbin reservoir watershed system : land management plan 2007-2017.* - (Sept 2007)

Contact : Tom Kyker-Snowman, thom.kyker-snowman@state.ma.us

4. Hanover

1. Presentation of the situation

The stadtwerke Hanover AG supplies each day 137, 000 m³ drinking water to 500, 000 Hanover inhabitants. Water is pumped from 110 wells situated in a watershed of 30, 000 ha. Forests cover 50 % of this watershed.

The protection area is divided into 4 zones : zone 1 is the area of wells (46 ha), zone 2 is defined as the area of water runs up to 50 days to the wells (806 ha), zone 3a is closer than 2km to the wells (8, 536 ha) ; the remaining catchment area is zone 3B (21, 000 ha).

Taxes are taken on water (5.1 ct/ m³ on drinking water and 1ct/ m³ on industrial water). 40 % of these taxes finance a fund to finance forest and agricultural measures, water supply infrastructures and consulting.

Water costs 60 ct/m³, which is very low for the region.

2. Type of action

Hanover has acquired land since 1908 and owns today 2, 000 ha of forest where all wells are situated.

3. Management implemented for the protection of drinking water

A new management program has been set up in 1996.

3.1 Particularities of the forest management on the 2 000 ha belonging to Hanover

The aim is to replace coniferous stands (pine plantations) into more « natural » forest stands. Deciduous trees (beech and red oak) are planted under pines.

3.2 Particularities of the forest management just around the wells

These zones are fenced.

3.3 Hunting and recreation management

Hunting is allowed. Deciduous seedling plantations (except beech) have to be protected from game browsing.

Recreation is very limited.

3.6 Pasture land or agricultural land management

Farming and pasture are regulated.

4. Forest situation

4.1 Forest characteristics

Soils are podzols and sandy gleys.

Annual temperature is 9.9 °C. Annual precipitation is 712 mm.

The terrain is not steep; elevation goes from 30 to 70 m.

4.2 Forest management

Water protection is the first management objective.

4.3 Ownership

2, 000 ha belong to Hanover among the 15, 000 ha of forest, which corresponds to 13 % of forested area (and 7% of the watershed).

5. Costs

A tax of 0.051 €/ m³ finances forest management and deciduous plantations.

6. Evaluation of the action plan

Since the implementation of forest and agricultural measures, nitrate concentration in water has decreased of 15 mg/l.

Water is filtered and chlorinated when maintenance work is done in the water pipes.

7. References

ZANDER (O.).- *Groundwater Protection Strategies of a Water Supplier*.- Stadtwerke Hannover AG

Contact: Olaf Zander, Stadtwerke Hannover AG, olaf.zander@enercity.de

5. Masevaux

1. Presentation of the situation

Masevaux is a town of 5, 000 inhabitants located in the Vosges mountains (North-East of France).

10 shallow underground water catchments situated in Masevaux public forest produce 700 m³/day.

Masevaux forest area is 1, 250 ha, the watershed area is 650 ha and the protection zones area is 240 ha.

Water costs 2.85 €/ m³ to consumers.

Masevaux city manages water supply, ONF manages the forest according to Masevaux wishes.

2. Type of action

Masevaux already owns the forest where the catchments are.

Particular actions are implemented with ONF to optimise forest and water management.

Masevaux develops communication and information with hunters, pupils and local people coming to cut fuel wood.

Projects with research organisms are being implemented to know better forest roles on water.

3. Management implemented for the protection of drinking water

3.1 Particularities of the forest management in PPR (inner protection zones)

Regulative measures in PPR:

Road construction/modification, chemical treatments, and deforestation on more than 1 ha, wood treatments, and cullwood deposition near catchments are forbidden.

Voluntary measures (innovation of Masevaux):

- Improvement of communication between ONF and water services: exchange of GIS data, ONF has to declare in advance when a forest operation will be done in a PPR.
- Cautious harvest: cable yarding in one parcel, biologic oils given to local people coming to cut fuel wood.
- Awareness raising of pupils: visits in forest, with ONF and water service.

When a cut is located near glens where water pipes go, cullwood are burn, to give a better visibility.

PPR forest stands are even-aged but regeneration period lasts 20-40-60 years, therefore soil is always covered by forest. Main species are beech and fir, many other deciduous regenerate also.



Forest stand in a PPR
(May 08)

3.2 Particularities of the forest management just around the water catchments points (above the water pipes)

PPI are dispensed of being fenced.



PPI of a water catchment (May 08)

3.3 Hunting and recreation management

A limited feeding is tolerated in PPR.

Recreation is not a problem.

3.5 Pasture land or agricultural land management

Agricultural lands are concentrated down stream.

4. Forest situation

4.1 Forest characteristics

The terrain can be steep; elevation goes from 395 to 1,190 m.

Annual precipitation is 1,400 mm. Temperature depends on elevation (8°C in average at 620 m).

Soils are brown and rich.

Forest site is beech-fir forest.

4.2 Forest management

Managers try to have 1/3 conifers and 2/3 deciduous in all the forest.

A wind throw recently happened.

4.3 Ownership

Totally owned by Masevaux city.

5. Relationships between the actors / stakeholders

Relationships between ONF and Masevaux are good.

6. Costs

A study is being done to evaluate the over costs in forest because of water protection.

7. Evaluation of the action plan

Water is chlorinated, it may be neutralised in the future.

8. References

FIQUEPRON (J.).- *Compte rendu de la visite du site de Masevaux.*– 28 novembre 2007

Contact : Jean de Marin (ONF), Pascal Masson (ONF)

Visit in Masevaux on 13/05/08

6. Munich

1. Presentation of the situation

Munich water comes mainly from the Mangfall river watershed (80 % of Munich total drinking water): one stream catchment and underground water catchment of 10 m depth.

41, 000 m³ are supplied each day to the 1.5 million Munich inhabitants. The Stadtwerke München (SWM) is responsible for water supply.

To protect the watershed, a protection zone, called « conversion zone » has been defined. It takes 150 days to water to go from the border of this zone to the catchments. The area is 6, 000 ha (2, 250 ha of organic farming + 2, 900 ha of forest).

Water costs 1.42 €/ m³ to consumers.

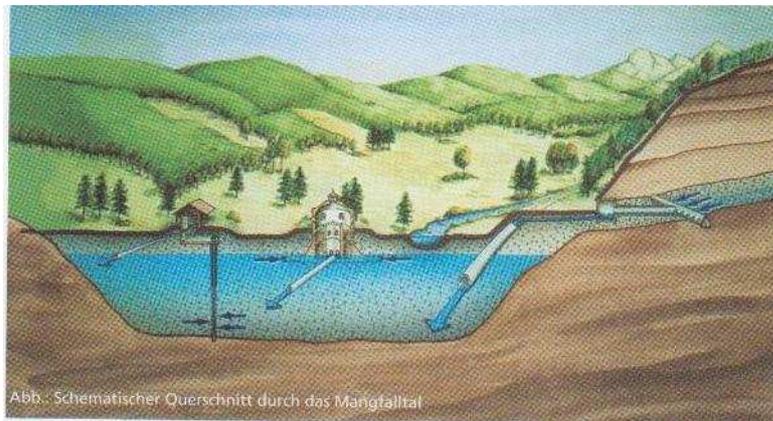


Abb. Schematischer Querschnitt durch das Mangfalltal
Source : SWM. – *M-Wasser, ein erstklassiges Naturprodukt*- 2005

2. Types of action

- Land acquisition

Munich city has acquired forest land or reforested during the last century. 1, 500 ha (among the 2, 900 ha of the forested conversion area) are owned by Munich, they are the most sensitive zones.

- Conversion to organic farming

After strong nitrate pollution in the 80s and 90s, a partnership has been established with organic farming associations (Bioland, Naturland and Demeter). Farmers who join one these associations and respect the organic farming rules receive, in exchange, financing from Munich city. About 500 €/ha/year are given to the organic farmers.

Today, more than 100 farmers have signed these contracts, which represents 1, 800 ha in the conversion zone (85 % of farmers) and 500 ha outside the protection zone.

Thanks to these measures, nitrates are not detectable anymore in Munich water.

- Public information

There is a lot of communication about the origin of Munich water, inhabitants are well informed. Visits are organised for pupils in forest.

3. Management implemented for the protection of drinking water

When Munich bought lands at the beginning of the 20th century, they have been reforested with spruce plantations. Since the 70s Munich forest service tries to diversify these forest stands to have more resilient stands.

3.1 Particularities of the forest management over the 1, 500 ha of Munich

The management objective is water protection and therefore to have a solid ecosystem, resilient to droughts and wind throws.

Actual stands are composed of 70 % of spruce. Managers try to regenerate them:

- favour deciduous trees regeneration (mainly beech, but also oak, maple, ash), and fir;
- continuous forest cover, uneven-aged forest (little openings in spruce stands);
- timber harvest in winter to prevent from bark beetles, with chainsaw/harvester, tractor extraction (when soil are too humid, no extraction);
- 50 to 100 m³/ha are harvested each year, rotation of 5 years (very productive site and not enough volume harvested in the past);
- pesticides are not allowed ;
- biologic oils are compulsory.

Munich forest is certified FSC.



Fir and deciduous trees regeneration under spruce (June 08)

3.2 Particularities of the forest management just around the water catchments

Three zones are defined:

- zone III: time of water transport is 150 days,
- zone II : time is 50 days,
- zone I : immediate area.

Forest management is almost the same in the 3 zones, but more surveillance is made for harvest operations in zone I and machines cannot stay there during the night.

Above water pipes catching shallow underground water, land is deforested on 10-15 m width.



Deforestation above a water pipe (June 08)

3.3 Forest road network

Road density is sufficient. Skid roads are every 40 m.

3.4 Hunting and recreation management

Hunting is realised by foresters to keep low population levels.

Recreation is abundant but is no problem (except maybe horse-riding).

3.5 Pasture land or agricultural land management

See paragraph 2

4. Forest situation

4.1 Forest characteristics

Annual precipitation is 1, 400 to 1, 600 mm. Elevation goes from 600 to 990 m. Slopes are not steep. Soils are deep and rich.

Site-suited species are beech and fir with other deciduous.

4.2 Forest management

The main objective of Munich forest is water protection.

4.3 Ownership

1, 500 ha (among the 2, 900 ha of the conversion zone) belong to Munich.

Private owners manage their forest as they want. They are informed about the water protection issues. The Land of Bavaria provides financial incentives to plant beech trees. Clear cuts are limited to 2 ha.

5. Relationships between the actors / stakeholders

Relationships with farmers are now good.

Munich city would like to define an official protection zone, but it leads to conflicts with the local cities that own this potential protection zone.

6. Costs

Costs of water supply are very low.

Prevention by organic farming costs less than 0.01 €/ m³ (to compare, nitrate and pesticides depollution costs are 0.23 €/m³).

Each year 40, 000 to 50, 000 m³ of wood are harvested in Munich forest (annual revenue of 3 million €/year). Revenues cover forest management costs.

7. Evaluation of the action plan

Water is not treated (except during flood periods).

8. References

Contact: Rainer List (waterworks manager) and Jan Linder (forest manager) from SWM
list.rainer@swm.de and linder@forstgotzing.de

Visit on 02/06/08 in Thalham (SWM office, Mangfall)

7. New York

1. Presentation of the situation

90 % of New York drinking water comes from the Catskill/Delaware watershed. The area of this watershed is 414, 000 ha. 2 rivers, Catskill and Delaware, are caught and “stored” in 6 huge reservoirs. The watershed is mainly covered by forests (75%) and by rural lands.

5 million m³ are produced each day to supply 9 million inhabitants.

Since 1993 (and 1997), New York City has decided to invest in watershed protection, instead of building a filtration and purification plant. Economic calculations showed that New York would spare 6 to 8 billion \$ (filtration plant cost) and 200 to 300 million \$ per year of maintenance cost. In 2006, the city confirmed the choice of protecting the watershed and reinforced its actions to do so.

The entire watershed is concerned by the same protection rules (land acquisition and comprehensive planning, water quality monitoring and disease surveillance, and upgrading wastewater treatment plans).

2. Type of action

- Land acquisition

The land acquisition program started 10 years ago. At this time, New York city owned 3.5 % of the watershed. After having solicited the purchase of 144, 000 ha, the city acquired 24, 000 ha (to voluntary owners, at the market price). Today, the city owns 5.8 % of the watershed and wished to acquire more land in the future.

The city gives public access to its land in exchange of the purchase of a visit permit. 102, 000 persons have bought this permit. 18, 000 ha are recreation area, 4, 000 ha are hunting area.

- Reserve

20 % of the watershed (82, 500 ha) belong to “New York State’s Catskill Preserve”. This reserve is totally forested but is voluntary unmanaged. It is open to public.

- Conservation easement

From 1997 to 2003, New York has signed conservation easements on 21, 000 ha for 131 million \$. 70 % of these lands are situated in very sensitive zone (490 ha in wetland).

- Wastewater treatment plant upgrade

- Stream, riparian buffer and wetland management program

To limit erosion problems, 13 huge riparian buffers restoration projects have been set since 1997. Private owners are informed of the importance of these zones that New York tries to acquire. Scientific research is also conducted there.

- Agricultural program

Over 95 % of large farms in the watershed enrolled in this voluntary program of good practices, for a cost of 18.6 million \$.

- Forestry program

Forests cover more than $\frac{3}{4}$ of the watershed and belong to thousands of private owners who have diverse management objectives. The temptation to sell or develop their land is huge. Moreover, the ecologic health of forest is threatened by invasive plants. The city has developed a partnership program to bring assistance and knowledge to forest owners. Education on BMPs and watershed ecology has been done. These trainings programs have been followed by 560 forest owners (40, 000 ha) who created after management plans on their forest, and 1, 500 forest loggers.

- Forest management assistance program

This program finances a part of forest work made in private forest (kind if incentive): plantation, work and improvement cuts in riparian buffers, fauna habitat conservation, invasive plants control.

- GIS monitoring and modelling of the watershed

- **Regulation of collect and treatment** of wastewater and fuel storing
- **Public information**

3. Management implemented for the protection of drinking water

Since 1997, 4 major orientations have been defined by the Watershed Agricultural Council (WAC) to protect the watershed.

3.1 Particularities of the forest management over all the watershed area

- Management plans

WAC organises educative programs to help forest owners to finance and write management plans which take into account water protection. Today, 529 owners have a management plan, covering 40,000 ha (of which 1, 200 ha in riparian buffers).

The management plans are evaluated every 10 years to see if forest owners comply with their plans. After the first evaluation, an assistance program has been created to help foresters to plan improvement cuts, realise plantations, and manage riparian buffers and habitats.

- BMPs implementation

WAC provides cost sharing, technical assistance and other incentives to loggers and landowners for implementing BMPs that prevent pollution during timber harvests and associated management activities. WAC developed programs to support the temporary installation of portable bridges, the proper construction of new timber harvest roads, the remediation of existing forest roads having erosion problems, the planting of riparian buffers along watershed streams... In addition, WAC recently modifies its forestry BMP eligibility requirements to provide increased incentives for loggers who are fully certified under the Trainer Logger Certification Program.

- Forest loggers education

WAC supports a voluntary logger training program to improve the quality of timber harvesting and promote logger safety. Between 1999 and 2002, WAC developed a “watershed qualified” training option whereby loggers who attended at least one water quality BMP training workshop would be eligible to participate in certain WAC cost-sharing programs. WAC is developing other actions to encourage loggers to receive this Trained Logger Certification (TLC).

- Research / education

WAC collaborates with a wide range of upstate and downstate partners to implement research, demonstration and forestry education programs throughout the watershed and within New York city.

3.2 Particularities of the forest management just around the water catchments points

WAC owns land around reservoirs, public access is not allowed. Management plans of these zones are very cautious.

3.3 Hunting and recreation management

Hunting is allowed in public and private forests. Too high deer population created regeneration problems. WAC tries therefore to organise hunting management plans.

Public recreation is very important: hunting, fishing, hiking, skiing, golfing and camping. While there have been isolated water quality problems resulting from some of these activities, there are not any widespread problems.

3.5 Pasture land or agricultural land management

95 % of farmers have signed contracts with WAC to apply BMPs.

4. Forest situation

4.1 Forest characteristics

The Catskill Mountains are the remnants of a high plateau deeply carved by water erosion. Topography is characterized by steep slopes (>15%) and deep, V-shaped valleys. The bedrock is chiefly sandstone and shale (sedimentary origin). Soils are generally stony and acidic.

The forests of the watershed are primarily Northern hardwood forests. Principal species include beech, red/sugar maple, white ash, black cherry, yellow birch and red/white/chestnut oak. Eastern hemlock, white pine and red spruce are also present. Most of the forests are in the 70-100 year age class (natural regeneration), having been harvested significantly in the past during the peak of agriculture. Many agricultural lands have been reverting back to forest cover.

High grading (cutting the best, leaving the rest) has traditionally been a common practice, so many of the forest stands are uneven-aged.

4.2 Forest management

The City, both internally as well as in partnership with many local organizations, actively supports long-term forest management on both City-owned and privately owned forest lands. The latter category comprises most of the forest land (~70%), so one primary objective of the voluntary NYC Watershed Forestry Program is to encourage/support the adoption of long-term forest management plans written for private landowners by trained professional foresters. These plans are written to strict watershed specifications which exceed NYS standards for plans developed pursuant to the NYS Forest Tax Law. As such, watershed forest management plans are required to include a thorough description of soil and water conditions/issues on the property, erosion control (BMP) recommendations, riparian management recommendations, and numerous other detailed descriptions regarding the status of current forest roads, stream crossings, and other erosion or water quality problems. The plans are voluntary, so it is the landowner's responsibility to follow these prescriptions.

Watershed forest management plans also contain very detailed information about the health, status, stocking volume, and species composition of all forest stands on the property, as well as a 10-15 year work schedule of proposed silvicultural prescriptions which address the forest type/composition based on the landowner's long-term property management goals. Thus, there is no uniform standard for what individual plans recommend in terms of silviculture - each plan is site specific and tailored to the property/landowner. Again, because the plans are voluntary, it is the landowner's responsibility to implement any silvicultural recommendations.

4.3 Ownership

Forest is mainly private. With land acquisition recently realised, New York City owns around 10 % of the watershed. The Department of Environmental Protection (DEP) will soon define a management plan for these forests.

5. Relationships between the actors / stakeholders

In terms of private forest landowners, the audience has been generally extremely responsive in a positive way, to various watershed protection efforts. Conservation easements are certainly a sticky subject, but landowners have a number of options to choose from and all options are voluntary.

It should probably be noted too, that forestry/silviculture in New York State (including the watershed) is a non-regulated and generally exempt activity, at least in terms of nonpoint source pollution. Regulations are generally triggered by the need to develop storm water pollution prevention plans for land clearing activities (building forest roads that impact a specific minimum acreage).

6. Costs

To date, NYC has spent or committed about \$1.5 billion to watershed protection. All DEP funds come from rates paid by water and sewer users. The watershed protection program is just a small portion of

the average consumer's bill – and watershed protection is considerable cheaper than filtration would be.

7. Evaluation of the action plan

DEP has a robust water quality monitoring program in place. This program has always formed the basis for water quality protection activities. New York City water quality has always been extremely good. In the 15 years that watershed protection programs have been actively engaged, there has been no degradation of water quality. In some localised areas monitoring has detected improvements in water quality. In short, the data confirms that programs are effective.

DEP reviews and revises its water quality protection plans every 5 years. These reviews are based on a comprehensive data set of water quality monitoring results, as well as professional judgement in managing the programs. The next scheduled to update programs is in 2011/2012.

Water is chlorinated, and fluoride is added to prevent tooth decay.

8. References

LLOYD (E.), RUSH (P.) (Bureau of Water Supply).-*2006 Long-term Watershed Protection Program*-. New York City Department of Environmental Protection, December 2006

BLOOMBERG (M.), LLOTD (E.). -*New York City 2006 Drinking Water Supply and Quality Report*-. New York City Department of Environmental Protection.

WATERSHED AGRICULTURAL COUNCIL WATERSHED FORESTRY PROGRAM. -*Forestry handbook*-. January 2008

Contact: David Warne (Chief of Staff, Bureau of Water Supply, Department of Environmental Protection, New York City, dwarne@dep.nyc.gov)

8. Saint Etienne

1. Presentation of the situation

30 to 50 % of the drinking water that supplies the city of Saint Etienne (France) comes from the Furan watershed. The area of this watershed is 1, 200 ha watershed for the catchment area (of which 600 ha belong to St Etienne city) and of 2, 500 ha for the reservoir. The forest cover is 100 % for the catchment area and 75 % for the reservoir.

Shallow catchment pipes (1.8 to 2.5 m of depth) catch underground water. Today, 31 km of water pipes are working. Water from these pipes supplies the 650 inhabitants of Rochetaillée and the surplus is mixed in a reservoir where rivers arrive (this very good quality water is “polluted” with the water of the reservoir and everything is filtered after). But water from these water pipes could supply 60, 000 persons (29, 000 m³/day).

Water supply is organised by a private company, the Stéphanoise des eaux.

Cost of water is very high (4.32 €/m³) but it is because of this polluting mixing of water.

2. Type of action

Since 1880, the city has acquired lands in the Furan watershed. Today, land acquisitions are still made (about 7 ha/year in average), near catchment zones or outside to exchange later the land with owners situated near the catchment zones.

The Stéphanoise des eaux has passed a contract (provision of services) with ONF for 22, 000 €/year. In exchange, ONF has to do a regular surveillance of harvesting activities nearby water pipes and of recreation, program the maintenance work of the pipes (master building), deforest just above the water pipes. Other services can be done by ONF under punctual estimate.

This provision of service is not equivalent to a contract where ONF would be remunerated for its protective forest management.

For information, another contract is passed between ONF and the city of St Etienne (2, 000 €/year) to increase surveillance against motorised circulation in forest.

Public information is done through notice boards in forest and pupils visits in forest.

No contract is passed with private owners. Their forest management is closed to the one applied in public forest managed by ONF. In addition, an ONF agent is always present in the watershed and checks that harvest operations are correctly done.

No contract is passed with farmers for the moment, but there is a project of land acquisition and tenant farming with farming restrictions (Life project).

3. Management implemented for the protection of drinking water

3.1 Particularities of the forest management over all the watershed area

Forest stands are mainly composed of firs. Ecologically, conditions indicate that the forest site should be beech-fir forest. Beech trees have been eliminated by foresters since a long time. Now foresters favour beech and deciduous trees.

Forest are uneven-aged (tree selection management), which is the traditional silvicultural treatment in this region.

Forest cut have a maximum volume of 50 to 80 m³/ha.

Pesticides are not allowed. Biologic oils are compulsory in public forests.

There is no real constraint for wood harvesting, except that machines are not allowed to pass over water pipes and no cullwood has to be deposited there.

3.2 Particularities of the forest management just around the water catchments points (above the water pipes)

These zones (PPI) have been dispensed to be fenced. Water pipes network is materialised with milestones and blue painting on trees.

Above water pipes, trees are cut. Deforestation width is 10 m for deciduous trees and 6 m for conifers (because they have smaller roots).

The water pipes network is being progressively renewed (they were made in sandstone, they are replaced by PVC). Each year, around 800 m of water pipes are renewed; up to now, 67 % of the network has been renewed. This work is realised by contractors, but ONF provides the master building.



Deforestation above a water pipe, with a milestone

Picture from Guillaume Sabot, ONF

3.3 Forest road network

No road is build above catchment areas.

3.4 Hunting and recreation management

Hunting is allowed, game populations are monitored.

Recreation is abundant in the forest. Motorised circulation is particularly controlled and repressed.

3.5 Pasture land or agricultural land management

25 % of the reservoir watershed is farm land (mainly pastures). Contracts with farmers are in project.

4. Forest situation

4.1 Forest characteristics

Mother rock is granitic, soils are deep and brown. Annual precipitation is 1, 000 mm. Elevation goes from 800 to 1, 250 m. Forest site type is fir-beech.

4.2 Forest management

Management objectives in public forest are 1) water protection and protection against flooding, 2) wood production and recreation.

4.3 Ownership

Half of forest in the catchment area is public. The rest is privately owned (small forest parcels and one big of 120 ha).

5. Relationships between the actors / stakeholders

Relationships between private forest owners and forest harvest enterprises are good, thank to the presence of one ONF agent in the watershed.

Forest management in public and private are very similar, except that private owners do not make forest work in young stands that. But this has no impact on water protection.

6. Costs

The over costs linked to water protection can be estimated by:

- the price of the contract with ONF (22, 000 €/year)
- the lost of forest area above water pipes (22 ha),
- the restrictions for harvest operations.

7. Evaluation of the action plan

Water “produced” by this forest has a very good quality. It is supplied to Rochetaillée inhabitants with just a preventive chlorination. But it is regrettable that after this water is mixed (and therefore polluted) with a water of bad quality.

8. References

Visit in Saint Etienne on 10/04/08 with Guillaume Sabot (ONF)

9. Tokyo

1. Presentation of the situation

Tokyo (27 million inhabitants) water supply comes from a 48, 000 ha watershed (rivers arriving in reservoirs). This watershed is totally forested. 44 % of forests belong to the Tokyo Metropolitan Waterworks Bureau (TMWB) and is specifically managed. The rest of forests (56 %) is privately owned is not managed.

About 4, 400, 000 m³ of water are produced each day.

Water costs around 2 €/m³ to consumers.

2. Type of action

TMWB manages the forests it owns.

No management is done in private forest, although important problems are known. These forests are almost “abandoned” because of forest industry decline. Only events like “Tamagawa suigenshintai” happen there: volunteers come in private forests to plant trees and do some selective cuts.

Tokyo inhabitants are aware of this forest protective function. Information and education are diverse: educative forest trails, projects with schools...

A demonstration forest has been created to train TMWB staff to forest management.

3. Management implemented for the protection of drinking water

The particular management of this forest started in 1901.

3.1 Particularities of the forest management over all the watershed area

TMWB manages 21, 630 ha of forest in the watershed. 15, 000 (70 %) are “natural” forests, and the rest, 30 %, are plantations.

Natural forests are located in mountains. On deep soils, they are composed of broadleaved trees (beech, oak, chestnut, ash, maple). On rocks, they are coniferous (*Tsuga diversifolia*, *Picea jezoensis*).

Plantations, aged from 0 to 100 years, are composed of *Chamaecyparis*, *Larix kaempferi* and *Cryptomeria japonica*. They are managed in 2 different ways :

- « Natural » forest (44 %), in less favourable forest sites; some conifers are cut to allow deciduous regeneration, forest stands are supposed to evolve to natural forest stands.
- Multi-layer forests (56 %) on favourable forest sites; a multi layered stand is re-created to evolve to uneven-aged forest (cutting, pruning, thinning, weeding...). Harvested timbers are sold. Pesticides are not allowed.

Natural forests are not managed (except sometimes to protect regeneration from game). Natural succession is expected to forward in natural forests.

3.2 Particularities of the forest management just around the water catchments points

There is no specific action to protect riparian buffers.

3.3 Forest road network

There are about 780 km of mountain trails to investigate the forest situations, to take care of plantations and to prevent emergencies like forest fires. Trails functions are maintained by weeding and building wood bridges along them.

46 km of firebreak belts are set on the main ridges to prevent from fire spreading.

12 forestry roads (72 km) are used for transportation of residents and timber.

3.4 Hunting and recreation management

There are important regeneration problems because of game (*Cervus nippon*). Protections are used.

Many tourists use trails to discover forest and participate to organised field visits. Tokyo inhabitants feel concern by forest management. Volunteers participate to different actions in private forest (plantation, cut). Some others grow saplings in their gardens and plant them after in forest.

4. Forest situation

4.1 Forest characteristics

Elevation varies from 500 to 2,100 m (alpine temperate zone to alpine subarctic zone). The terrain is steep. The geologic situation consists of mainly 3 types; granodiorite whose geological age is estimated Tertiary, sandstone and shale of Mesozoic and Paleozoic strata distributed eastern part. Soil types are categorized into 3 groups; brown forest soil, podzol and black earth. Annual temperature ranges from 8.5 to 13.1 °C; annual precipitation from 1,552 to 1,684 mm.

4.2 Forest management

See 3.1

4.3 Ownership

44 % of forest is public (56 % private).

5. Costs

The management of watershed forest contributes to the conservation of the raw water quality and thus, it enables to save the cost for water treatment at purification plants. However, the quantification of the contribution by the watershed forest is difficult.

7. Evaluation of the action plan

Water quality is monitored periodically. It is impossible for managers to compare the quality between before and after implementation because the management began over 100 years ago.

Though, the survey shows that mitigation of surface soil spillage is essential for the water quality conservation. Therefore, managers result that conservation of water quality attributes to the fosterage of sound forest.

Water is filtered before distribution to Tokyo inhabitants.

8. References

contact : Naomi Takahashi, General Affairs Division, Bureau of Waterworks, TMG

BUREAU OF WATERWORKS TOKYO METROPOLITAN GOVERNMENT. – *The watershed forests*. – 2008

10. Vienna

1. Presentation of the situation

Almost all Vienna drinking water comes from the catchment of 2 main spring water pipelines, coming from 3 mountainous Karstic areas (Hirschwang, Nasswald and Wildalpen).

Approximately 400, 000 m³ of water are consumed each day by the 1.78 millions inhabitants of Vienna.

The protection zone of the watershed has an area of 60, 000 ha of which approximately 33, 000 ha belong to the city of Vienna. 2/3 of this zone is covered by forests. The last third is composed of pasture lands, alpine meadows and rock formations.

Water costs approximately 1.2 €/m³ to Viennese people.

2. Type of action

Since 1870, the city of Vienna has been buying lands situated in the watersheds and therefore has built 2 pipelines to bring the spring water to Vienna.

Today, the city owns about 33, 000 ha and has adopted since the late 80s new forest management practices in accordance with nature-near silviculture with the primary aim to protect drinking water resources.

The rest of the zone belongs to private owners that apply a conventional productive forest management, but 2 federal legislative decrees restrict some land practises (for example, it is forbidden to store oil or polluting materials, build new infrastructures without authorization, transport dangerous materials...).

Scientific research plays an important role. The implementation of the new forest management has been done in partnership with Boku University and different projects have been lead there (like Kater projects – see www.kater.at).

Communication and public information is largely available over the protection zone. Authorities try to keep a « soft tourism » there.

3. Management implemented for the protection of drinking water

Since the late 80s, a new forest management has been implemented in the area owned by Vienna: nature-near silviculture, no clear-cutting, fostering natural regeneration, careful harvesting and extraction (cable-yarding), no chemical agents (herbicides, pesticides, fertilisers etc.), and regulation of game.

A site-classification inventory has been realised on the entire protection zone to know the actual forest stands characteristics, and also ecological parameters, like information about natural vegetation, soils, exposition, elevation...

The hydrotope model has been applied to determine which natural forest stand would be the most adapted to protect drinking water resources. GIS has been used for this purpose.

Since then, in function of these results, foresters manage the stands to bring them as close as possible to their optimum defined by the hydrotope model.

3.1 Particularities of the forest management over all the watershed area owned by the City of Vienna

The management objective is to obtain uneven-aged forest stands (group selection system), with diverse tree species. The majority of stands is for the moment spruce plantations.

Managers try to open them and bring regeneration, by using the following methods.

- No clear cut, only small intrusions to the canopy to the maximum extent of 0.5 ha.
- Continuous forest cover → uneven aged forest.

- The silviculture institute of Boku university recommends to have a forest cover between 70 and 90 % (60 to 80 % in subalpine zone).
- Continuous forest regeneration by natural rejuvenation.

If possible, natural regeneration by the group selection method is used. The silvicultural institute of Boku university recommends that the diameter of openings should not be larger than 1/3 of tree height, but the total regeneration area must be 10-20 % of the total area. All species recommended by the hydrotope model must be regenerated.

Light-demanding species like larch are important species and regenerated by strip cutting on the “edges” of old stands.

- Different layers and different ages of trees.
- Improve tree vitality and stability by forest tending and structure thinning.
- Limit the harvested volume.

The silvicultural institute of Boku university recommends that not more than 10-15 % of the stand volume should be harvested for each cut. Forests (and other land types) are managed with the aim of maximum protection of watersheds and not with the objective to gain maximum yield (on average only about 2/3 of the possible yield is actually harvested).

- Hunt sufficient game to have enough regeneration.
- Keep some old trees.
- Let some dead wood.
- Restore buffer forest along dolines, wetlands and rivers.
- Adopt more environment-friendly harvesting systems : cable yarding. Tractor skidding only on so-called green zones when weather condition are good (GIS-based site classification model).
- Introduce all species recommended by the hydrotope model.
- Use of biodegradable oils, no use of pesticides.
- Permanent sample plot inventory to monitor the stands evolution.

3.2 *Forest road network*

The forest roads density is pretty sufficient for primarily using cable crane systems (about 20-30 meters per hectare thus about half of the average road density in Austria).

Road planning and construction are in accordance with the MA49&MA31 guidelines. Hydro geologist of the Vienna Waterworks (MA31) inspects the site first. Road-building is realised with excavators only. Sometimes fleece in the base course / layer of the forest road is used to buffer possible effects during construction or further traffic on the roads.

3.3 *Hunting and recreation management*

Hunting is a great tradition in Austria and it is difficult for foresters to accept to feed game less and shoot it more. A zoning has been created to limit areas where game can stay without being shot, and where it cannot (regeneration zones for example).

But game browsing induces big problems of regeneration (very difficult to regenerate tree species except spruce without protection).

Tourism is limited in the protection zone, but not forbidden. Authorities try to keep it soft (only hiking, no trail in sensitive zones, only one camping area, delivery of waste, subsidies for sewage systems to tourist lodges and huts). Hikers are well informed and there is no particular problem.

3.4 *Pasture land or agricultural land management*

There are pasture lands in the protection zone. Some farmers have historical rights to come there with their cattle. But today, less and less farmers use these pasture lands, they receive subsidies as incentives to do so. In very sensitive areas grazing is forbidden.

Forest managers try to respect the equilibrium between forest stands and *Pinus mugo* zones, because the characteristics of these 2 ecosystems towards water retention are different (higher snow accumulation in *Pinus mugo*).



Spruce stands opened 6 years ago by cable yarding. Regeneration comes with difficulty (May 08)



A mosaic of vegetation in higher elevation (May 08)

4. Forest situation

4.1 Forest characteristics

The protection zone is situated in the North East of the calcareous Austrian Alps. The elevation varies from 470 to 2, 277 m a.s.l.. The aquifer is Karstic, the rock types are limestone and dolomite.

The main soils are rendzic leptosols and cambisols.

The average annual temperature varies from 6.7 and 9.4 °C, the annual rainfall between 614 and 1, 071 mm.

Forest stands were mainly composed of spruce (60 %) and far from the « natural potential associations » that could have been there.

4.2 Forest management

Practices in forest management have totally changed since the late 80s. But this management is only applied in the forest owned by Vienna; private owners do what they want in their forest. Since 2001 there are basic guidelines for the management of the protection areas – a joint venture of MA49 (Forestry Office) and MA31 (Vienna Waterworks) covering the themes of forest management, tourism and agriculture.

4.3 Ownership

Vienna owns 33, 000 ha of the 60, 000 ha protection zone that is 2/3 forested. Therefore, the share between public and private forest is approximately 50 %.

5. Relationship between the actors / stakeholders

The relationships with private owners do not seem to cause any problem or conflict.

The City of Vienna gained step by step ownership of the most important and sensitive areas concerning protection of mountainous spring water in history of about 140 years. Large areas in the Hochschwab region (Styria) are protected by law for the purpose of providing drinking water to Styrian communities (including the provincial capital Graz) and are not of primary interest to the City of Vienna.

Forest clear cuts are limited to 1 ha (2 ha normally in Austria).

Scientific research has always played an important role. Studies are still being conducted to optimize forest management and also to face the challenges of tomorrow, like global warming or society evolutions (for example, there are less and less alpine pastures, but they are more and more concentrated in some areas).

6. Costs

The cost of forest management is financed by Vienna City.

6% of the price of water is used to compensate for these extra-management costs.

7. Evaluation of the action plan

It is difficult to determine if this new forest management has an impact on water quality, because, before the 80s, the assessment of water quality was really different from now. Nevertheless, a recent storm, Kyrill, has devastated some forest stands and effects to the water quality could be mastered because of a online-quality management using only those springs within the very tight limits of quality parameters. Managers compare this storm to the effects of a clear cut, which reinforces their management choices.

The Wildalpen forest management in Styria (2nd spring water conduit) was affected by about the 4th of the average annual yield or timber production (~35,000 m³). Primarily scattered wind throw and wind break damages. The largest site affected by the KYRILL-wind-throw was about 20 hectares in a impassable, subalpine region and there about 6, 000 m³ were only debarked with the help of the Austrian army soldiers (a so-called “Assitzenzeinsatz” to prevent a bark-beetle outbreak by the Austrian army because of the public interest and importance of the area to the water supply of the capital city of Austria). Private forests were rarely affected.

Water is chlorinated to a very small, computer-controlled amount before being supplied to people because of sanitary reasons (about 3, 800 kilometers of total length of water supply system) – not because of any quality reasons of the spring water

Authorities find this global management plan performing but they are always looking for possible improvements.

8. References

Personal interviews with Werner Fleck, Eduard Hochbichler and Gerhard Kushnig in January 2008 in Vienna, visit with Werner Fleck and Bernhard Mang in Hirshwang forest on 23/05/08

HOCHBICHLER (E.), KOECK (R.), MAGAGNA (B.).- Kater II Handbook : final report regarding the land use category forestry-. BOKU University,2007

HOCHBICHLER (E.), KOECK (R.), MAGAGNA (B.).- Kater II Handbook, Appendix I : Best management practises for the drinking water protection forests-. BOKU University, 2007

<http://www.wien.gv.at/english/environment/watersupply/index.html>

11. Vittel

1. Presentation of the situation

Nestlé Waters owns the mineral water of Vittel, Contrex and Hépar, situated on a watershed of 10, 000 ha in the Vosges, on 9 different cities. 310 ha of forest belong to Nestlé and are managed by ONF. Forest cover in the watershed is approximately 11 %.

A branch of Nestlé, called Agrivair, has been created in 1992. This society organises water production and watershed management.

Water comes from deep wells situated in Nestlé forest or in other public forest.

2. Type of action

After nitrates pollution problems in the 70s and 80s, Nestlé acquired farm lands since 1987.

These lands are freely given to farmers (tenant farming of 18 or 30 years), who have to respect rules not to pollute.

Since the nitrate pollution decreased in water.

3. Management implemented for the protection of drinking water

Since 1999, ONF manages Nestlé forest. The management objectives are 1) water protection, 2) public recreation, 3) wood production (but a financial balance is wished), 4) hunting.

3.1 Particularities of the forest management in Nestlé forest

Forest stands are mainly composed of oak (coniferous stands have been harvested). To guarantee continuous forest cover, uneven-aged forest (group selection system) is applied. The aim is to have mixed species stands, with big oak trees and other deciduous trees in under layer.

Before, forest stands were even-aged. They are progressively converted (little regeneration openings of 0.1 to 0.2 ha).

One to two dead trees per hectare are let for biodiversity.

Harvest operations have to respect environment: biologic oils, respect of soil, harvest in winter or along skid roads, horse extraction if necessary, surveillance by ONF agent. Pesticides are not allowed.



Oak and deciduous trees forest stand, coming progressively uneven-aged (May 08)

3.2 Particularities of the forest management just around the water catchments points (above the water pipes)

No specific rule (deep wells, not very sensitive).

3.3 Forest road network

Forest road density is about 2.4 km/100 ha.

Runoff water on roads (outside forest) are collected to prevent from infiltration in water table.

3.4 Hunting and recreation management

There is no particular problem because of game.

Recreation is important: cycling, horse riding. A golf in forest is very popular.

3.5 Pasture land or agricultural land management

Farm lands are regulated by tenant farming contracts.

4. Forest situation

4.1 Forest characteristics

Annual precipitation is 923 mm, annual temperature is 8.7°C.

Elevation goes from 330 m to 450 m. Slopes are not steep.

4.2 Forest management

The first objective is water protection.

4.3 Ownership

Forest covers 11 % of the watershed. 2/3 are public forests and 90 % of private forest belong to Nestlé (310 ha).

Public forests are made of uneven-aged or even-aged (with 15 years of regeneration period, progressive cuts) forest stands, and are composed of oak mainly.

5. Relationships between the actors / stakeholders

Problems are mainly solved by communication and negotiation.

6. Costs

It is very difficult to estimate over costs due to water protection in forest because of the golf area that brings also a lot of harvest restrictions (no timber extraction from 15 April to 15 October).

7. Evaluation of the action plan

The nitrates concentration in Nestlé forest underground water is below 10 mg/l.

Water is not treated (mineral water).

8. References

FIQUEPRON (J.).- *Fiche de travail : Action conjointe INRA & IDF : forêt et eau.* – Fiche de travail provisoire sur Vittel.- 10/10/06, 3p.

Contact : Philippe Humbertclaude (ONF) philippe.humbertclaude@onf.fr, Agrivair 03 29 07 60 30

Visit in Vittel on 14/05/08 (Philippe Humbertclaude from ONF and Philippe Pierre from Agrivair)

12. Winterthur

1. Presentation of the situation

The city water service of Winterthur supplies 90, 000 inhabitants, 27, 000 m³ are delivered each day.

8 (out of 9) wells are situated in Winterthur forest. They catch water from the alluvial water table of the river Töss.

Winterthur is one of the most forested cities of Switzerland, with 2, 635 ha of forest, of which 1, 900 belong to the city. 100 ha are in protected zone.

Water is delivered without any treatment.

2. Type of action

Winterthur has acquired forest lands since long time and is still purchasing new ones today.

3. Management implemented for the protection of drinking water

In 1950 huge areas belonging to Winterthur have been reforested. In the 80s and 90s, protection zones have been defined around catchment areas.

3.1 Particularities of the forest management over all the watershed area

Winterthur forest service has a “close to nature” management on the 1, 900 ha of forest. Natural regeneration is favoured and no big clear cuts are made. Biologic oils are used; machines circulate only on skid roads.

In the beginning of the 20th the river Töss has been corrected and riparian forest transformed in beech stands. Now, natural flooding zones have been re-created and Winterthur forest service tries to re-create riparian forests.

Today, there are 63 % conifers and 37 % deciduous trees in forest.

3.2 Particularities of the forest management just around the water catchments points

In protection zones, particular precautions are taken for timber harvest.

Log landings are not allowed, which induces over costs of transport. Storing and manipulation of fuels and lubricants is forbidden.

Since 2002, these over costs are not part of the city forestry budget, but they are attributed to a budget for “nature, landscape and water protection”.

3.3 Pasture land or agricultural land management

In the protection zone, the city has recently modernised a farm to produce organic milk.

It is not allowed to use fertiliser and give antibiotics to cattle.

A lot of information is missing on this site because no one of the managers I contacted answered to me.

4. References

HAAGMANS (B.), KUNZ (B.).- Les forêts de la ville de Winterthur protègent l’eau potable-. *Journée internationale de la forêt 2003*

Appendix 4: Description of « Best management practices »

Best Management Practices (BMPs) are effective, practical, structural or non-structural methods which prevent or reduce the movement of sediment, nutrients, pesticides and other pollutants from the land to surface or ground water, or which otherwise protect water quality from potential adverse effects of silvicultural activities. These practices are developed to achieve a balance between water quality protection and the production of wood crops within natural and economic limitations.

A thorough understanding of BMPs and the flexibility in their application are of vital importance in selecting BMPs which offer site specific control of potential nonpoint source pollution. With each situation encountered at various sites, there may be more than one correct BMP for reducing or controlling potential nonpoint source pollution. Care must also be taken to select BMPs that are practical and economical while maintaining both water quality and the productivity of forest land.

The Federal Water Pollution Control Act Amendments of 1972, Public Law 92-500 (and as amended by Sec. 319, 1986), require the management of nonpoint sources of water pollution from sources including forest-related activities. BMPs have been developed to guide forest landowners, other land managers and timber harvesters toward voluntary compliance with this act. Maintenance of water quality to provide "fishable" and "swimmable" waters is central to this law's objectives. The Environmental Protection Agency (EPA) recognizes the use of BMPs as an acceptable method of reducing nonpoint source pollution.

Nonpoint source is diffuse pollution that comes from almost everywhere; it even occurs naturally to a certain extent. The amount of pollutants from any particular spot is small and insignificant, but when combined from over the landscape, can create water quality problems. Although it is unrealistic to expect that all nonpoint source pollution can be eliminated, BMPs can be used to minimize the impact of forestry practices on water quality. These practices must be reasonable, achievable and cost effective. The adoption and use of BMPs will provide the mechanism for attaining the following water quality goals:

- to maintain the integrity of stream courses;
- to reduce the volume of surface runoff originating from an area of forest management disturbance and running directly into surface water;
- to minimize the movement of pollutants i.e. pesticides, nutrients, petroleum products, etc. and sediment to surface and ground water;
- to stabilize exposed mineral soil areas through natural or artificial revegetation means.

In practise, BMPs focus on:

- the creation and maintenance of forest roads,
- rivers and streams crossing,
- recommendations of timber harvesting in wetlands.

The monitoring and evaluation of BMPs application and efficiency has very recently started to be implemented.

Appendix 5: questionnaire for Alpeau sites

1. Presentation of the situation

Type and number of catchment points, area of the total watershed, area of the protected zone of the watershed, percentage of forest cover over the watershed, number of people relying on drinking water from this watershed, number of m³, price of water

2. Current water supply system

Current water supply system, actors

Current prescriptions/management around catchment points

Current water quantity and quality? Water treatment? Any encountered problem (pollution...)?

3. Current forest situation

3.1 Forest characteristics

Geologic situation, main types of soils

Topographic situation

Ecological type, natural forest communities

Actual situation (species composition, type of forest stand, volume, annual increment...) Tree species composition, silvicultural treatment (even aged or uneven aged stands, clear cut regulation, type of regeneration...), harvested volume per cut, regulation/restrictions for harvesting, use of chemical products/ pesticides...

3.2 Forest management

Management objectives

Actual situation (species composition, type of forest stand, volume, annual increment...), tree species composition, silvicultural treatment (even aged or uneven aged stands, clear cut regulation, type of regeneration...), harvested volume per cut, regulation/restrictions for harvesting, use of chemical products/ pesticides...

3.3 Ownership

Percentage of public or private owners

3.4 Forest road network

Erosion/runoff problems?

3.5 Hunting and recreation management

Any particular measure or problem?

3.6 Pasture land or agricultural land management?

4. Relationships between actors

Relationships between water and forest managers?

With private owners? Problems or conflicts?

Any contract with private owner?

5. Expectations of Alpeau managers

Why taking part in this interreg project?

Objectives ?

6. References

Appendix 6: Filled questionnaires of the Alpeau sites

1. Areuse gorges

1. Presentation of the situation

Neuchâtel water supply comes mainly (85 %) from the Areuse gorges, situated at 14 km in the North West of the city.

The watershed is mainly forested. The area is about 4x2 km². Neuchâtel water catchments are located on the left side of the river.

22, 000 m³ of water is delivered each day to 50, 000 persons.

Water costs about 1.50 CHF/m³ for supply (total cost of 4.50 CHF/ m³).

The terrain is Karstic, several small streams are caught. There is also a water catchment in the Areuse water table (alluvium).

2. Current water supply system

The public company Viteos manages Neuchâtel water supply (and also gas and electricity).

Water is chlorinated (but not filtered like water from the lake).

Water quality is globally good but one part of water catchments is in contact with Areuse River (up to 12 % of water from the river in some catchments). When there is too much suspended matter, the stream is deviated. But there is a risk of pollution in Areuse River (industries upstream) and therefore a risk of water catchment pollution. Studies are implemented to understand better this phenomenon.

3. Current forest situation

3.1 Forest characteristics

Elevation goes from 400 to 1, 000m.

3.2 Forest management

The management objective is forest multifunctionality with a silviculture “close to nature”.

Forest stands are mixed and multi-layered (uneven-aged), with 25 % of spruce, 25 % of fir, 40 % of beech, 8 % of maple and 2 % of other broadleaved. The standing volume is about 300 m³/ha. Increment is 6 m³/ha/year.

Harvest techniques are traditional. Logs are treated outside of S1 and S2 zone. A big part of the forest is in protection zone and as a consequence, wood treatment is almost impossible.

Biologic oils are used.

The forest is certified PEFC.



Forest stand in the Areuse gorges (June 08)

3.3 Ownership

Forest belongs mostly to Neuchâtel city (95 %).

3.4 Forest road network

The soil is permeable; there are few problems of erosion and runoff.

3.5 Hunting and recreation management

This forest is a reserve. Game populations are high.

Recreation is important (cycling, hiking). A recreation management plan is being done.

3.6 Pasture land or agricultural land management

There are some farmers on the right side of the Areuse gorges.

4. Relationships between actors

Relationships between different partners are good. Viteos has organised meetings with farmers to raise awareness about water protection. Good practices are now applied without financial compensation.

5. Expectations of Alpeau managers

Alpeau manager's expectations (University of Neuchâtel) are only scientific. Research studies will be implemented during Alpeau project:

- Interpret data collected since 40 years on water quality, link it with past forest harvest and soil vulnerability;
- Make some experiments to measure physic-chemical quality of infiltration water, in function of forest type and forest management.

6. References

Visit in Areuse gorges on 11/06/08 with Pierre-Olivier Aragno from Viteos and François Zwahlen from Neuchâtel University

Contact : Jan Boni from Neuchâtel forest service

2. Arve watershed

1. Presentation of the situation

The Arve watershed represents about 40 % of the department of Haute Savoie, so around 1, 750 km². 250 to 300 water catchments are concerned, mainly shallow underground catchments and wells in Arve water table. They supply about 250 000 persons with water, but population can increase a lot there during winter and summer holidays.

Water costs about 2.70 €/m³.

The water pipes network yields are very low: 53 % in average (some at 30 %), although water agency recommends yields of 70 %.

Forest cover is 35-40 % over the watershed: 170, 000 ha, of which 100, 000 ha are private forest which is much divided (100, 000 ha owned by 100, 000 owners who have in average 3 parcels → average parcel area in private forest is 3, 000 m², so very difficult to manage).

2. Current water supply system

Water supply is organised by city services or inter-city services that can manage water supply by themselves or delegate this competence. 42 joint associations manage different aspects linked to water in the Arve watershed (river management, wastewater, drinking water...).

Half of water catchments do not have any treatment (it corresponds to 11 % of the total volume of water). The majority of the other half is only disinfected.

Water has globally a good quality (bacteriologic and chemical).

Some problems of shortage during winter recently happened. Water tables levels decrease progressively.

The town of Annemasse is an interesting case. One part of its drinking water is bought in Switzerland, but this water is very expensive. Annemasse decided to develop shallow underground water catchment in Salève Mountains. Water pipes have been renovated and yields increase a lot. The city also acquired forest land around water catchments to protect this little watershed.

The SM3A (Syndicat mixte de l'aménagement de l'Arve et de ses abords) is partner of the Alpeau project in this Arve watershed. This joint association gathers several city or inter-city services dealing with water, but not drinking water.

3. Current forest situation

3.1 Forest characteristics

Forest is mainly coniferous (majority of spruce stands above 1, 000 m, fir-beech stands between 800 to 1, 000m, and oak-ash forest below 800 m).

Spruce have always been favoured by foresters every where, but because of recent dieback (wind throws, bark beetles), spruce is not recommended below 1, 000 m.

Geologic substrates are very diverse, slopes are steep.

Water is abundant (1, 300 to 1, 500 mm of annual precipitation). Annual temperature varies from 5 to 9°C.

3.2 Forest management

In public forest, management objectives are production and protection.

The silvicultural treatment is uneven-aged forest (group or single tree selection system). No clear cut superior to 1 ha is planned. Timber is extracted by tractor (by cable very seldom). Biologic oils are used and pesticides are not allowed.

During a visit near the town of Arraches, it has been possible to see some PPI (immediate protection zone) in a communal forest. PPI are fenced, trees are let, but grass is mowed every year. Big diameter trees have been recently harvested in the PPI. The fence had to be removed for the operation and re-installed after. No cullwood has been let on the PPI ground. The town which owns the water catchment do not want that deciduous trees regenerate on the PPI “because they fear that deciduous tree litter bring to much organic matter to the soil”.

A forest road is just above the PPI. Runoff from ski tracks upstream “flow” in this road and arrive in the PPI, which can be a problem.

ONF, that manages the forest, ignores which type of catchment it is, where the pipes are and what their depth is.

In the PPR (inner protection zone), there is no particular constraint. ONF is transforming since 10 years spruce plantations by uneven-aged forest stand of mixed species (spruce and some deciduous). ONF managers open progressively spruce stands around natural regeneration patches. This silvicultural treatment requires very cautious harvest operations, not to damage the remaining trees. This is why an ONF agent is always present when the forest cut is being done.



PPI in Arraches public forest (July 08)

Private forest is much divided. Forest parcels are or unmanaged, or cleared-cut.

3.3 Ownership

60 % of forest is private.

3.4 Forest road network

The forest road network is correct. When managers plan new roads in PPR, a hydro geologist has to give his/her agreement.

3.5 Hunting and recreation management

Game is present but has little impact on regeneration.

Touristic frequentation is high, which induces constraints (cities cannot harvest their forest in July and August). Regulations are taken against motorised circulation in forest. It can be difficult to answer all the recreation wishes, as the demand is very diverse.

3.6 Pasture land or agricultural land management

In valleys, cattle could have a negative impact on water quality (nitrates, pesticides...).

In alpine pastures, animal faeces and liquid resulting from altitude milking (cheese fabrication) can pollute also water catchments downstream. Pasture concentration is not equally distributed.

4. Relationships between actors

When water catchments are situated in private forest, owner identification can be a difficulty. Sometimes, if they do not cooperate, they can be expropriated.

There are very few relationships and communication between water managers and foresters. They are much more developed with farmers.

Pollution from urban areas and industries remain a problem, despite improvements.

5. Expectations of Alpeau managers

With Alpeau, SM3A wished to extend its competences in the field of drinking water. This joint association plans to write a global water plan management for the Arve and therefore needs to acquire knowledge and competences in drinking water aspects.

The goal is to know more about the impact of forest on drinking water quality and to quantify economically this impact.

During Alpeau, SM3A plans to:

- realise an inventory and a typology of all catchments,
- evaluate the impact of a good or bad forest management on water quality (economic valuation),
- develop contract between foresters and water managers to adopt good practices,
- improve forest management in PPI.

6. References

Visit in Bonneville on 05/06/08 and 23/07/08 with Hervé Fauvain (SM3A) and Jean-Luc Maboux (ONF)

3. Broye region

1. Presentation of the situation

The research office Nouvelle Forêt situated in Freiburg (Switzerland) is partner of Alpeau project in the Broye region (cantons of Vaud and Freiburg). The precise water catchments-forests to be studied during Alpeau have not been determined yet. Different forest areas are possible, like Mont-Gibloux.

In Switzerland, drinking water protection is a duty for forest owners. Restrictions due to this protection cannot be compensated (but they are compensated for farmers).

Drinking water comes from lakes (1/3 of total water volume), water table pumping (1/3) and streams or shallow underground water catchment (1/3), of which 40 % are located in forest. Water from lake presents problems of micro-pollution. Pumped water presents problems of agricultural pollution. It seems therefore necessary to invest in forest water protection.

Nouvelle Forêt has participated to the elaboration of a forest regional management plan in 2003. After, the "Forum Broyard de la forêt et du bois" has been created to implement and monitor the evolutions of this regional management plan.

One of the commissions of the forum deals with water and forest. It has been tried to establish contracts between foresters and water managers, but no one has been signed for the moment. This commission edited three publications.

For information, a study is being realised by the WSL on costs and yield decrease in forest due to water protection.

2. Current water supply system

Water supply is the responsibility of cities that can gather in intercity associations. Communes own the water catchments.

In Broye region, the majority of water is not treated. However, many catchments in farming areas are polluted in nitrates.

Usually, protection zones are both on forest and farm lands.

In forest, chemical treatments on logs during May and June can induce pollution.

For the moment, there is no risk of water shortage.

Water costs 1 to 3 CHF/m³ (without wastewater treatment).

3. Current forest situation

3.1 Forest characteristics

Terrains are from molasses, sometimes covered by moraines. Soils are brown typed;

Except few steep valleys, slopes are soft.

Elevation ranges from 430 to 800 m.

Forest site is beech with *Galium odoratum*.

3.2 Forest management

Forest management objective is multifunctionality.

During the last century, there were many spruce plantations. But they have nearly been also devastated by wind throws in 1999, followed by drought in 2003 and bark beetles.

Today 50 % of forests stands are young, mainly composed of deciduous trees (natural regeneration or plantations of beech, oak, ash...). Some plantations of larch and Scott pine have been done. Forest management is more and more extensive because of these young stands.

The other half of forests stands are even-aged beech stands (but beech tree is sold at a very low price in Switzerland).

Harvester is seldom used. Extraction is done with forwarder (sometimes with tractor or cable yarding).
Silviculture is close to nature, cuts are usually small.
Biologic oils are uses. The only polluting products are chemical wood treatments.

3.3 Ownership

Forest is public at 53 %. Private forest is very divided.

3.4 Forest road network

Forest roads are usually sufficient.

3.5 Hunting and recreation management

Recreation is important near the lake, but there is no water catchment there.
Game populations are not high, there is no problem for regeneration.

3.6 Pasture land or agricultural land management?

There are many farms in the area.

For information, Nestlé recently bought the Henniez mineral water and acquired forest land around.

5. Relationships between actors

The forum broyard commission tried to raise awareness on over costs linked to water protection in forest, but water managers have not been very receptive.

However, systems of financial compensation already exist to remunerate forest diversity or recreation.

5. Expectations of Alpeau managers

With Alpeau project, managers wish:

- know better about forest impact on water quality,
- establish contract between foresters and water suppliers.

6. Case of Mont-Gibloux (potential Alpeau site)

This 750 ha forest is situated on 5 towns (public forest). There are many water catchments supplying with water 5, 000 inhabitants. Water is delivered without any treatment.

More than 1/3 of forest is classified as protection zone.

Soils are from molasses and moraines. Elevation goes from 950 to 1, 300 m. Forest site is beech-fir.

Main constraints linked to water protection are the forbidding of wood treatment, of road construction in S1 zones and parking machines in protection zones.



Water catchment under a spruce stand in Mont Gibloux (June 08)

7. References

Visit in Freiburg with Robert Jenni on 09/06/08

4. Chambéry

1. Presentation of the situation

Chambéry water supply comes mainly from pumping in water table (85 %). The other 15 % come from 68 shallow underground water catchments. Actions will be implemented on 7 of them during Alpeau project and 4 are already defined:

- Dhuy water catchment in St Sulpice,
- Pierre Rouge water catchment in Vimines,
- Fontaine Froide water catchment in St Badolph,
- FontaineNoire water catchment in St Jean d'Arvey.

2. Water catchments descriptions

2.1 Dhuy water catchment

The PPI is 235 m², the PPR is 504, 126 m². It gives water to 600 persons (flow from 1.72 to 4.44 l/s in 2006).

The elevation is 662 m. the aquifer is Karstic.

Forest sites go from oak-beech, beech, fir.

A part of the PPR is in public forest. Forest stands have been recently destroyed by bark beetles, standing volume is very low. No forest cut is scheduled before 2021. Stands are composed of beech and firs, with some other broadleaved.

2.2 Pierre Rouge water catchment

The PPI is 7, 851 m², the PPR is 30, 543 m². It gives water to 700 persons (flow from 0.6 to 10,5 l/s in 2006). Water is treated to UV.

The elevation is 600 m. the aquifer is Karstic.

Forest sites go from oak (*Quercus pubescent*) to beech-fir.

The public forest situated in the PPR is composed of deciduous trees (beech, maple, oak...) and managed as coppice and standards (4 year rotation). Dolines are fenced. There are also pastures on the PPR.

PPI is deforested and grass is mowed 2 times a year.

→ Change prescriptions on PPI, make an experimental cut on PPR.

2.3 Fontaine Froide water catchment

This water catchment is situated near from another catchment. They give water to 50 persons (water flow in Fontaine Froide from 0.42 to 3.37 l/s). Water is chlorinated.

The elevation is 1, 290 m. Geology is limestone. Forest site is beech-fir.

Forest stands on PPR are even-aged and composed of spruce, fir and beech.

PPI is deforested and grass is mowed 2 times a year.

→ A forest cut is scheduled in 2008 and 2012 on different parcels of the PPR. Water quality could be monitored during harvest operations.



PPI of Fontaine Froide (June 08)

2.4 Fontaine Noire water catchment

The PPI is 15, 411 m². It gives water to 1, 100 persons (flow from 3.71 to 9.69 l/s).

The soil is made from sandstone, clay, and shale.

Some parcels of the PPR are public forest. They are uneven-aged forest stands, of spruce and fir, with some beech and maple. Forest site is beech-fir.

Forest cuts are planned in 2008 and 2010, water quality could be monitored.

The decree for the PPI prescriptions has not been taken yet. Chambéry managers would like to keep forest on it.

Currently, there is a spruce plantation (in the future PPI). As spruce is not optimal for water protection, this plantation could be opened to regenerate beech and fir under spruce, like it is done in Munich or Vienna.

Water from the catchment has a lot of suspended matter and too many bacteria (pasture). There is too much Iron in water (sandstone). Therefore water is ultra-filtered. Maybe these problems will hide the potential good forest management effects on water quality.

3. Relationships between actors

Chambéry water managers and ONF do not communicate enough. There is almost no relationship with private owners, except conflicts (owner problems in PPI).

Relationships are more formal with farmers.

4. Expectations of Alpeau managers

Chambéry managers wish with Alpeau to:

- know more about the impact of good/bad forest management on water quality,
- adapt better prescriptions in PPI and PPR,
- monitor water quality and quantity thoroughly near forest harvest.

5. References

Visit in Chambéry on 18/06/08 with Etienne Cholin (Chambéry water manager) and Olivier Lamy (ONF)

5. Côte region

1. Economic and politic context

The forest service of Vaud canton has lead a group thinking in 2004 with public forest owners (forest is 80 % public) because of wood revenue decrease. An action plan has been created in 2006 to promote wood uses. Another group studied the valuation/remuneration of water protection by forests, like it has been done in the Broye region.

2. Geographic context water supply

The Lemman Lake dominates the valley. Above there are vineyards on moraines, and above there is the Jura forest, on Karstic soils.

An important part of drinking water comes from steams in Karstic forests and some in moraines. Globally water quality is good. Quantity is enough but this region is developing a lot, demographic pressure increase. As a consequence, towns begin to link their water networks.

The farming demand for water increases also and cities have to pump water in the lake. But pumping is very expensive and consumers do not appreciate to drink water from the lake.

Cities try to promote water from forests which is cheap and of good quality. They inform inhabitants about the origin of water. For example, the city of Gland deliver to its 10, 000 inhabitants a water almost exclusively from forest.

Constraints in forest due to water protection are very high. In Karstic area, almost all the forest is in protection zone. The main difficulty is that it is not allowed to treat wood and to park vehicles. Timber harvest is only possible in spring and autumn. The logistic forest-sawmill cannot absorb all the logs on time, and therefore wood treatment remains a necessary alternative, which induces problems.

3. Identification of 2 interesting sites

Two particular sites have been identified for the Alpeau project.

- City of Gland

This city is very motivated to promote water from forest. Water comes mainly from streams in Karstic area. Another stream is located on moraines, in a small forest where the only access road has been classified as S1 zone, which makes timber harvest almost impossible. In these 2 cases, forests do not belong to the city of Gland (but to other cities or private owners).

Moreover, the city of Gland feels very concerned by sustainable development and wishes to acquire a good image in this field.

- City of Aubonne

This city owns 450 ha of forest in Jura and in the plain, but these forests do not directly protect water resources. Aubonne water comes from a artesian well. Except the immediate protection zone around the artesian well, there is no S2 or S3 protection zone.

Like Gland, Aubonne would like to develop renewable energy (hydraulic electricity already) and extend it to water supply.

4. Possible projects

These 2 towns could create a global project linked to sustainable development and promote a regional use of wood, reorganise the wood industry chain, provide favourable and incentive frames, reduce supply circuits, create new local markets, raise awareness of public on timber harvest and other forest functions.

Such project implies credits and financing. A sustainable development fund, like in Lausanne, could be created for that.

Another role of this fund could be to allocate land to soil transformation entreprise at a cheap price. The land price is going higher and higher in this region and a sawmill, for example, could not be built in the region because land is too expensive.

Alpeau could give a start to the implementation of these projects.

5. Description of the 2 Alpeau sites

5.1 Gland

Water supplying 10, 000 comes from many streams in karst and moraines. The city of Gland manages its own water supply.

The protection zones of these streams are situated in forests that belong to other cities for the majority. The total surface is very high.

Water quality is good and available in quantity. Streams on moraines are very low treated (UV) and streams from karst are chlorinated.

Moraines elevation goes from 400 to 800 m and karst elevation from 800 to 1, 500 m. Forest site is beech forest and beech-fir forest in higher altitude.

Currently, stand composition is 50 % spruce, 30 % fir, 15 % beech and 5 % of other broadleaved.

Up to 1 200 m, forest stands are almost uneven-aged (large group selection system). Above, managers apply a plenter forest system.

Increment in Karstic zones is very low (~ 4 m³/ha/year). Tree growth is therefore very low.

Management objectives differ in function of altitude. In lower elevation, foresters want to have a mix of 50 % deciduous (beech) and 50 % conifers. In higher altitude, only conifers (with some maple) are favoured, beeches remain in under layer and are cut at 20 cm diameter (too bad quality).

Timber harvest is realised with chainsaw and harvester. Extraction is made by tractor. Conifers are treated from April to May but foresters try to reduce treatment. During the two last years, no log was treated (very good organisation between loggers and sawmills) but this was possible only because the market was favourable.

Annually, the harvested volume is 150, 000 m³, of which 15, 000 m³ in spring. Biologic oils are used systematically.

Forest is certified PEFC and FSC.

No problem of water pollution (suspended matter) linked to timber harvest has been detected. This can be explained because soils are very shallow (mother rock appears on the ground). The risk of pollution does not come from material transport, but from an accidental infiltration of polluting liquids in karst.

Constraints come from the forbidding of log treatment and machines parking. Bur legislation is not very clear and foresters have different interpretations.

Forest road network is sufficient.

Hunting is allowed. Game population make fir regeneration more and more difficult.

Recreation is important, but stays reasonable.

There are pastures above forest stands, also situated in protection zones. A faecal pollution accident happened in the 80s. Since then, a pasture management program with good practices has been implemented and no accident ever happened anymore.



Forest stand in Karstic Jura mountain (June 08)

5.2 Aubonne

In this case, no direct relationship exists between forest and water.

Water from the artesian well has a very good quality, except it has too much Iron.

Water is supplied to 2, 700 inhabitants.

However, Aubonne city is conscious that forest plays a very important protective role: artesian water comes from Jura Karstic forest and Aubonne owns there an agroforestry farm of 500 ha.

Therefore the city feels concerned by this issue that is included in a wider sustainable development view.

6. References

Visit in Saint George with Eric Tréboux (forest service of Vaud canton) on 12/06/08

6. Lausanne

The precise Alpeau site in Lausanne has not been defined yet.

1. Presentation of the situation

8 to 10 % of Lausanne water comes from shallow underground water catchments situated in a forest called Jorat. This forest belongs to Lausanne city. About 60 catchments are located in this 1,900 ha forest (95 % of S1 zones are in forest). Water flow is around 3,000 m³/day, supplying 18,700 persons.

Water catchments S1 zones are materialised by milestones in forest.

Water costs 1.95 CHF/m³.

A tax of 2 cents CHF is taken on each consumed m³ of water, as well as a tax on gas and electricity and also on industrial city services benefits. For information, this fund receives each year around 3 million CHF (~1,800,000 €). With this money, Lausanne develops several actions:

- Use and promotion of wood (« un arbre-un enfant », sawmill, bus shelter, pedagogic hut, parking, promotion of deciduous trees ...);
- Research and studies ;
- Public relations, communication, information ;
- Support to associations ;
- Education (sport, obesity prevention, waste recycling...);
- Other isolated realisations (children council, subsidy for gas vehicles, bio ethanol for public services, batrachians « roads »...).

For information, this fund finances a part of Alpeau project.

2. Current water supply system

Lausanne water service organise water supply. Relationships with forest service are now established (after a long inexistence).

Water from catchments is chlorinated. Water pipes networks are connected with water pumped from the Lemman lake. Water managers prefer to use water from the forest catchments during the day and pump water during night (because electricity is cheaper).

Water quality and quantity are satisfying. However micro-pollution problems are happening in water from lake.

Concerning forest catchments, water is deviated during storms to prevent from suspended matter problems.

3. Current forest situation

3.1 Forest characteristics

Forest stands on molasses partially covered by moraines. Elevation varies from 600 to 900 m. Annual precipitation is 1,200 mm. Forest covers different watersheds. Main forest site is beech-fir forest.

3.2 Forest management

This public forest has a multifunctional objective: recreation, timber production (15 to 20,000 m³ of wood per year), protection (water, erosion). Conifers dominate (old fir and spruce plantations) but deciduous trees regenerate naturally actively. Managers want to increase the deciduous trees proportion but keep a majority of conifers. Forest is almost uneven-aged (large group selection system).

Timber harvest is made with harvester in conifer stands, extraction is realised by tractor.

Conifer logs are treated after harvest; foresters try to reduce more and more this treatment.

Biologic oils are used systematically.

Forests are certified FSC and PEFC.

Constraints linked to water protection in forest are low. They do not induce over costs, except S1 zones materialisation and wood treatment forbidding. But these over costs are very low compared to over costs linked to recreation and biodiversity. For information, Lausanne forest service has an annual deficit of 3 million CHF (because of not-remunerated activities).



Forest stand in S1 zone (June 08)

3.3 Ownership

Forest belongs to Lausanne city.

3.4 Forest road network

Forest road network is sufficient.

3.5 Hunting and recreation management

Hunting is allowed. There is no regeneration problem because of game.

Recreation is very important but does not induce problems to protect water.

3.6 Pasture land or agricultural land management

Very few farm lands are concerned by water protection zones downstream.

4 Relationships between actors

Water and forest services begin to communicate and exchange experience.

Some contracts are signed with farmers to compensate for restrictions due to water protection.

Scientific studies are being implemented, in particular on micro-pollutants.

5. Expectations of Alpeau managers

Lausanne Alpeau managers wish to :

- Participate to a research project and promote water from forests,

- Maybe sign contract with foresters,
- Develop exchanges between water and forest managers,
- Maybe extend the water catchment network in forest,
- Monitor thoroughly some water catchments.

6. References

Visit in Lausanne with Philippe Magnenat (forest service) and Linda Viguet (water service) on 10/06/08

7. Moises-Forchat

1. Presentation of the situation

The Alpeau site of Moises-Forchat is composed of 8 water catchments, located on 3 watersheds (Moises, Pamphiot-Orcier, Menoge-Habère Poche).

The Syndicat Intercommunal des Eaux des Moises (SIEM) is a joint association of cities which manages water supply of 15 towns near the Lemane Lake, which represents 23,000 to 35,000 persons. More than 50 % of water comes from forest shallow underground catchments; the rest comes from pumping in the lake and water table.

Forest cover of protection zones is about 85 %.

The mean flow of water catchment is 6,000 m³/day, which gives water to 30-35,000 persons.

Water produced by the SIEM is sold 1.17 €/m³ to consumers.

2. Current water supply system

The SIEM owns 4 out of the 8 water catchments part of Alpeau. The other water catchments are managed by the towns where they are located (Habère Poche and Lullin).

Water catchment treatments differ: some are chlorinated, some other not.

The prescriptions in the protection zones are:

- in PPI : it is not allowed to go there, except for the water catchment maintenance.

- in PPR : motorised circulation (except authorized vehicles), deforestation, soil excavation, new road creation, pollutants introduction in the soil are not allowed.

Concerning forest management in PPR, uneven-aged forest is recommended and no clear cut > 50 ares are allowed.

Problems of suspended matter load and bacteria occur regularly in water, but it is difficult to identify the origin of the pollution.

During summer, water catchment flows can be very low. The SIEM pumps more in the lake and water table during this period.

An accident happened in 2002 after non-authorized maintenance work on a forest road in a PPR. Suspended matter and bacteria loads increased in water.

The SIEM wishes to develop water from forest because it is cheap and sustainable.

The SIEM has acquired some forest lands situated in protection zones and owns today 30 to 40 ha. These forests are unmanaged for the moment. Alpeau project could be the occasion to establish management plans.

3. Current forest situation

3.1 Forest characteristics

The aquifer is Karstic, the hydro geologic system is very complex.

Soils are brown (acidic on moraines or alkaline on limestone).

The terrain is very diverse (different slopes and expositions).

Precipitations are abundant in spring and summer. About 1 m rain falls on Thonon les Bains (400 m). The elevation gradient is + 60 to 80 mm every 100 m.

Water catchment elevation ranges from 990 to 1,180 m.

Annual temperature is 11.26 °C in Thonon les Bains (400 m). The elevation gradient is – 0.5 °C every 100 m.

Main forest site is beech-fir forest.

3.2 Forest management

Forest stands are mainly composed of spruce, fir and beech (with maple and ash in lower altitude). Increment is 12-13 m³/year.

Pesticides are not used.

Private forest is much divided and the parcels are very small (3,000 m² in average). When owners manage their forest, which are mainly spruce plantations, they clear cut them. Normally, in protection zone PPR, clear cuts superior to 5,000 m² are not allowed. But forest cooperatives manage to group owners that have contiguous parcels, each one smaller than 5,000 m², but realise on each one clear cut. Therefore, the cumulated area cleared cut can reach several hectares, which represents a real danger for water protection. In addition, they usually to clear the soil after, gather cullwood on strips, and plant spruce between, although natural vegetation works perfectly (natural seedlings come into artificial plantation).



Clear cut, just above a PPR (July 2008)

The association of private forest owners of Haute Savoie organises trainings to encourage owners to manage better their forest. A lot of actions are made to group forest owners together, to have sufficient forest area to manage it after in a sustainable way. But owners' grouping is very difficult.

Some PPR are situated in public forest managed by ONF. These forests are uneven-aged (group selection system) of spruce, fir and beech. The same forest management is applied by ONF on the whole department of Haute Savoie, independently from water catchments.

3.3 Ownership

2/3 of forest are private (100,000 ha of private forest, that belong to 100,000 different owners who have each one 3 parcels in average). The mean parcel size is 3,000 m².

In protection zones, private forest area is superior to public forest areas, but the situations are very different from one water catchment to another.

3.4 Forest road network

Many forest roads cross PPR. But road network is not enough to apply an uneven-aged forest management everywhere.

3.5 Hunting and recreation management

Recreation is very important. There are some problems with horse-riding and motorised circulation.

3.6 *Pasture land or agricultural land management*

There are some pasture zones in watersheds which bring pollution into water. Studies are being done to determine the origin and how it can be solved.

4. Relationships between actors

The SIEM wishes to have more relationships and to exchange information with public (ONF) and private foresters.

Two demonstration forests are in project to raise foresters' awareness to water protection.

The SIEM communicate more with farmers. There are some projects of contracts for pastures.

Conflicts could occur about timber harvest in protection zones and some recreation activities.

The SIEM collaborates with many research organisations for different studies.

5. Expectations of Alpeau managers

With Alpeau, the SIEM wishes to:

- know better about the hydro geologic processes in this region,
- optimise forest roles for water protection (on scientific view and then to create contracts),
- make an economic study to evaluate water supply costs from different origins and with different forest management,
- adapt prescriptions in PPI and PPR.

For information, the SIEM has also the project to create a hydro geologic park in this region (same area as Alpeau site) to optimise water resource protection.

6. References

Visits in Perrignier (Haute Savoie) with Bertrand Deville (SIEM), Nicolas Wilhem (SIEM) and Jean-Luc Maboux (ONF) on 17/06/08 and 22/07/08

Visit in Annecy with Noël Gentric (President of private forest owner association) on 15/07/08