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OUR NATIONAL RESOURCES, THEIR CONSERVATION AND UTILIZATION.

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THE title "Our National Resources and their Utilization" will be understood as applying specifically to the United States, and chiefly to what may be termed Continental United States. Alaska and the insular possessions which have enlarged the national domain, each have possibilities worthy of a full presentation, but it has been considered advisable to confine the discussion this evening mainly to the portion of our country bounded on the north by Canada and the British Possessions, on the south by the Republic and the Gulf of Mexico, on the east and west respectively by the Atlantic and Pacific Oceans.

This area of 3,000,000 square miles of territory, varying in topography from 270 feet below ocean level in the Salton Sea to nearly 15,000 feet above this datum, includes enormous areas of productive arable lands, great river valleys, magnificent mountains, extensive deserts, some of which are being converted into fertile lands, a fair amount of forests, extensive plains on which

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millions of cattle and sheep graze, and beneath the soil sources of present and prospective wealth in a variety of useful minerals and precious metals.

It shall be my endeavor to indicate some of the resources of the territory mentioned, and general features of their conservation and utilization. To discuss all in detail would make unnecessary demand on your patience, and those referred to will be treated as indicative of the balance.

The Press throughout the country has been practically unanimous in approval of the conference of Governors and other delegates, who by invitation of the President of the United States met in Washington in May, 1908, to consider the natural resources of this great country; and such endorsement has awakened public interest in a national problem of grave import, now being considered by a special commission.

The Washington conference and the studies of the Conservation Commission should, and it is sincerely hoped will, result in present and future good, but excerpts from the papers, discussions and statements credited to delegates which have been published, suggest that some of the enthusiasm for conservation, as it appears to have been understood, encourages conclusions scarcely warranted by facts.

This good movement must win by impressing its necessity and also its practicability upon the thinking people of the United States, whose support is to be gained by calm consideration. Oratorical pyrotechnics, theoretical discussions or dire prophecies which fail to stand criticism, will not secure conservation, and while great waste must be admitted, what is rated as Yankee ingenuity is to be credited with marked economies and progressive development.

The United States has moved with giant strides, and in material advancement "Uncle Sam" has worn the fabled "seven-league boots." Our spurts of speed have not been without damage, nor have our goals been gained except by sacrificing much of value. Some of this loss has been necessary—much of it the reverse, and it is not my purpose to condone waste, or apologize for practices which fail to secure the best results from the materials used, but to endeavor to discuss the problems broadly and equitably.

The introductory paragraphs of resolutions passed at the Washington conference may express the intention of this lecture.

"We, the Governors of the States and Territories of the United States of America in conference assembled, do hereby declare the conviction that the great prosperity of our country rests upon the abundant resources of the land chosen by our forefathers for their homes and where they laid the foundation of this great nation.

"We look upon these resources as a heritage to be made use of in establishing and promoting the comfort, prosperity and happiness of the American people, but not to be wasted, deteriorated or needlessly destroyed.

"We agree that our country's future is involved in this; that the great natural resources supply the material basis upon which our civilization must continue to depend, and upon which the perpetuity of the nation rests."

When requested to participate in this course the topic suggested was: "Conservation of Our Natural Resources," but in accepting the pleasant duty of addressing you, I asked that "Utilization" be added to the scope of the lecture, as these two must go hand in hand in our national development, for the locking up of a resource is not conservation and should be criticised as severely as waste.

According to our dictionaries, the definition of conservation is "the act of guarding or keeping with care; prevention from loss, decay, injury or violation, the keeping of a thing in a safe or entire state," and that of resource is "property that can be converted into supplies, available means or capabilities of any kind."

The conservation of resources is not therefore merely holding them in reserve for the future, but judicious practical utilization, *i.e.*, "turning them to profitable account or use, making them useful, or making use of them."

There have been given to us by nature resources of enormous volume and value the utilization of which has made this country great, and promise for it a bright future. Our duty is to use and also to conserve. In fact, utilization is not thorough except when associated with conservation, nor is conservation effective except as a consort of utilization. The proper employment of any natural resource takes into consideration future supplies and eliminates unnecessary waste, for we cannot lavishly use our natural resources and yet maintain a supply for posterity, particularly of such as are not reproductive. It may be practicable to maintain our farming and grazing lands; to provide for a continuous application of water for transportation, irrigation, supply or power by reforestation and by impounding reservoirs; or it may be possible by forest propagation and protection to maintain a supply of wood for future uses, for these are replenished,

but we cannot renew the coal, the oil, the ores, or other minerals taken from the ground.

The conservation of natural resources must be considered in relation to a rapidly growing population, expanding over and developing wide areas of territory; their utilization must be profitable, and such as will best assist and not retard this development.

We are not excusable if in pursuit of business activities we neglect provision for those who may follow us, and no patriot desires to look forward to a decadence of the nation. But while appreciating a duty to posterity, we cannot load the present generation with inequitable burdens. Hence the determination of what is proper conservation and utilization of our national resources demands careful conscientious investigation by every lover of his country.

I recognize the value of enthusiasm in effecting any reform, and cheerfully credit those who may be classed as enthusiasts with patriotic motives, but I cannot endorse a late editorial which assigns the growing interest in conservation to the theorist, the doctrinaire, for conservation has been and is the constant endeavor of many practical men and women who make use of our resources.

It is not he who cries "Wolf! wolf!" but he that slays the wolf, who is the benefactor.

The abundance of our resources has not forced upon the United States the practical conservation necessary in other countries, but every invention which increases the possibilities of our country, every reduction in the unit of fuel or power required for a given amount of work, each useful purpose to which otherwise waste material is applied, every detail which lowers the cost of production, manufacture or transportation, is a step toward true conservation, and is to be credited with its share in the material progress of the nation, both present and prospective.

Thousands of active brains study economic problems, the solution of which adds to the material wealth of the country and the comfort of our people, by reducing the consumption of resources, lowering costs of production, or converting waste into valuable materials. All of these may be features of conservation and utilization, considered in connection with the permanence of the United States as a nation.

MINERALS.

Forests, water, soils and all minerals are considered natural resources, and the latter will receive first attention by some statistical data. Notwithstanding the freedom with which quantities and values are discussed in tens and hundreds of millions, few grasp the true meaning of such arrays of figures, and to assist in appreciating the production of the more important minerals some are reduced to daily averages, others being recorded by yearly outputs.

The United States produces 1,600,000 tons of *Coal* each working day, and of this amount Pennsylvania contributes nearly one-half.

The United States Geological Survey claims that with an average of 30 cars of coal to the train, and of 50 tons to the car, the number of trains required to transport the coal production of the United States in 1907 would be 320,300, the combined length of these trains extending two and two-thirds times around the world at the equator.

The *Iron Ores* mined in 1907 represent a daily output of 170,000 tons, more than one-half of which was won from the mines in Minnesota, a state which has been a producer for but 25 years.

In the same year

Lead and *Zinc* to the amount of 1,900 tons per day were obtained, mostly west of the Mississippi River.

Copper, chiefly from Arizona, Montana and Michigan, was produced at the rate of 1,400 tons daily.

And *Gold* and *Silver* valued at \$425,000 per day attest the volume of our metalliferous products.

Add to these a daily product of:

555,000 barrels of *Petroleum*,
170,000 barrels of *Cement*,
Nearly 100,000 barrels *Salt*.

Also yearly outputs representing values of

\$159,000,000 in *Clay Products*,
\$53,000,000 in *Natural Gas*,
\$84,000,000 in *Sand and Stone*,

\$10,000,000 in *Phosphate Rock*,
\$6,000,000 in *Slate*,
\$5,000,000 in *Aluminium*,
\$5,000,000 in *Sulphur*,
\$5,000,000 in *Gypsum*,
\$7,300,000 in *Mineral Waters*,
\$2,800,000 in *Asphalt*,

and other minerals wrought on a liberal scale, and the magnitude of our mining industry may be appreciated.

The mineral production of the United States at points of distribution represented for the year 1907 a value in excess of two billion dollars—one third of this total being credited to Pennsylvania. We are using these resources at an enormous rate; to what extent are we conserving them?

SOIL PRODUCTS.

By preventing erosion, fertilizing our farms and caring for them and their products, our soil as a resource supplies quantities staggering in their magnitude. The figures for some of these for the year 1907 are:

Corn, 2,592 million bushels,
Wheat, Oats, Rye, Barley, Buckwheat and Flaxseed, an aggregate of 1,614 million bushels,
Potatoes, 298 million bushels,
Hay, 64 million tons,
Cotton, 11 million bales,
Sugar (cane and beet), 761,000 tons,
Tobacco, 349,000 tons,
Rice and other products, 19 million bushels.

Our soil supports 74 million *cattle*, 27 million *horses* and *mules* and over 112 million *sheep* and *swine*.

Irrigation projects estimated to cost \$70,000,000 are now being carried forward, with the expectation of converting 2,000,000 acres of barren land into fertile fields, and interest lately has been directed to the reclamation by dikes and drainage of 126,000 square miles of swamp lands.

Water as a resource is applied everywhere, as a necessity for communities, manufactories, transportation and navigation. It is required in great quantities for domestic and municipal use,

for crops and for all industries, and estimates of volume or value are difficult to formulate.

One authority gives the available water power of the country as 25,000,000 horse power, and states that out of the 16,000,000 horse power supplied one-fourth of it is produced by water power.

The forests furnish our timber and lumber necessary for homes, structures, railways, vessels, and other products; and statistics indicate that the people of the United States use 500 feet board measure per capita per annum, as against 60 feet average for European countries, the estimate of standing timber being 1,400,000 million feet, with an annual cut of 100,000 million feet. Our methods of construction and radical improvements in saw mills and taxation systems are responsible for this heavy inroad, but the waste in the use of lumber is enormous.

Air is a resource essential to life and to all processes of manufacture, but its service is materially lessened by treating it as a convenient medium for the removal of vapors and solid matter which menace the public health, disturb home comfort, and cause monetary damage to personal property.

Legislation for ameliorating what is termed the smoke nuisance and for the control of fumes, has had little effect in diminishing the undesirable features of vitiated air, but ultimately the cost of abating these must be offset against the damage which results, and the utilization of what is now wasted will increase.

We cannot throttle industries, or restrict transportation by drastic legislation, but we may demand such an appreciation of the rights of those who suffer illness, inconvenience or financial loss, as will limit objectionable features.

The air we breathe is not affected appreciably by the draughts upon it, and its plenitude encourages us to give it scant attention, but we are surely wasting a natural resource when we unnecessarily make it undesirable or offensive.

As the advance in the quantities produced has been unprecedented, and some of the materials enumerated have been practically made usable within late years, it is judicious and proper for each American to consider what the future demands will be; the possibility of meeting these; the extent to which curtailment is practicable and the opportunities of substitution.

At the Washington conference gentlemen recognized as au-

thorities in specialties were invited to present various problems and made studied addresses, some of which, as reported, appear open to criticism, because they apparently neglect the relations of contemporaneous conditions.

Following a period of phenomenal activity it was natural that statistical comparisons be made with the year immediately preceding, but it may be inequitable to formulate opinions of prospective increase on records of the immediate past, to base deductions on the daily or annual statistical data, such as presented, unless we take into consideration applications of certain materials for specific uses, or recognize the advances and economies made.

Progress is not to be measured merely in quantities produced, but by the economical uses of our resources.

COAL.

In his address at the Washington conference the President made the statement, which was widely copied by the press, that the Nation's increase in the consumption of coal in 1907 over that of 1906 exceeded the total consumption of the year 1876, a comparison better understood when we consider that in 1876 coal was not so universally used for fuel as in 1907, and that many now productive fields were unknown or undeveloped in the Centennial year.

The population of the United States in 1876 approximated 45,000,000, and the Census Bureau estimates the population in 1907 as 85,500,000, and that of the year 1906 as 84,000,000; *i.e.* it was necessary in one year's time to supply 1,500,000 more people with coal for various uses. In 1876 there were 77,500 miles of railroad in the United States; in 1907 there were 324,000 miles; thus in the 30 years the railroad mileage had been augmented more than four times.

Other uses of fuel, such as the marvellous development of transportation on the Great Lakes and on the ocean, might be named, but the above are sufficient to indicate the greatly changed conditions.

In the Centennial year there were 1,868,961 tons of pig-iron made, of which 15 per cent. was produced with charcoal. In 1906-7 less than two per cent. of the pig-iron made was produced with vegetable fuel, and the pig-iron tonnage credited

to 1907 was 25,800,000 tons, nearly thirteen times the output of 1876.

Since 1876 important industries have been largely developed or created, which consume fuel liberally. The application of electricity for power and light, now almost universal, was practically unknown in the Centennial year, and the greater portion is generated by the consumption of fuel in plants whose capacities are measured by tens of thousands horse power, one plant in Philadelphia approximating 50,000 horse power.

The growing use of electricity for light has however been met by advances in gas manufactured. Statistics of the production of illuminating gas in 1876 are not extant, the earliest annual production available being that for 1883, which was 27,877 million cubic feet. A calculation from proportionate growth estimates the quantity for 1876 as 22,000 million cubic feet, while for 1907 the figure of 102,140 million cubic feet is given, nearly five times the estimated production of 1876.

The Portland Cement Industry, which produces over 50,000,000 barrels per annum, is also a late development.

The output of Bessemer steel and its merchantable products has increased from 469,000 tons in 1876, and the open-hearth steel manufacture, which was then in its infancy, has grown to equal the Bessemer product, viz., 11,500,000 tons in 1907.

In 1876 Pennsylvania furnished less than 23 million tons of anthracite coal, in 1907 nearly 86 million tons, but in the latter year the amount of anthracite coal sold which was of sizes unmarketable in 1876 or which was recovered from waste dumps approximated the entire anthracite coal product of the Centennial year.

Although Pennsylvania is the largest producer of coal, the area of its coal fields places it eighth in rank among 33 states whose aggregate workable coal fields area is estimated at 327,000 square miles.

Other uses of fuel, such as the employment of gas producers and gas engines, the marvellous development of transportation on the Great Lakes and on the Ocean, might be named, but the above are sufficient to indicate the greatly changed conditions.

Reduced to a per capita coal consumption, each inhabitant of the United States used in 1876 1.17 tons per annum, and in 1907 5.62 tons per annum, a startling comparison, if we fail to

appreciate the coal fields opened in the past 30 years, and the large areas unwrought which are known to hold liberal reserves of fuel.

Had President Roosevelt added to his remarks concerning coal, that, had we used fuel as wastefully in 1906 and 1907 as in 1876, the yearly annual increase for consumption would be more than double the production of 1876, the real advance of the country would have commanded attention without weakening the plea for conservation.

Coal has been the basis of the development of this country, but our best engines are calculated as obtaining but 10 to 15 per cent. of the energy in the coal which is converted into work. As further substitutes in part for coal, peat, petroleum, alcohol obtained from waste vegetable products, etc., may be factors.

Another speaker, in discussing the coal problem, stated that 25 per cent. of the coal in the developed mines is lost beyond recovery. Admitting this statement as true, and admitting deficiencies in present practice, the former losses do not prevail to an equal extent in present operations, where improved mining methods, recovery plants for reclaiming waste or beneficiating inferior material are multiplying.

With augmented population, increased railroad mileage, the establishment of all electric power transportation and lighting systems, larger pig-iron and steel outputs, new and diversified uses for fuel, the growth in its consumption, as presented, is not fairly comparable unless numerous economies introduced, and increased refinement of manufacture are considered.

While the text of the addresses at the Washington conference indicated that utilization was considered as embraced in conservation, the great mass of the people read only the salient features presented by press reports, which, unfortunately, held aloft the danger signal without giving credit to the progress made.

IRON ORE.

A successful iron master, basing conclusions upon a consumption of 1,200 pounds of iron ore per inhabitant last year, prophesied that in 30 years one-half of our supply of original iron ore will be exhausted, and that in a generation we must depend upon the leaner ores.

If these lean ores should be our reliance, which is not admitted, they will average about the same proportion of iron as the mineral fed to blast furnaces when Mr. Carnegie entered the iron business, from which he retired with a great fortune. He has seen the development of the Lake Superior iron ore region and its rapid growth, until 80 per cent. of domestic ores used come from this district and have displaced local ores, many of which lie dormant. He has seen the upbuilding of a magnificent iron and steel industry, resulting from the abundance and excellence of these ores, the district reaching the phenomenal output of 42,000,000 tons in 1907, with individual mines contributing one and one-half to two million tons each. But the output of 1907 may not be again reached for years; the curve of annual production of iron and steel, which in the last decade was approaching the vertical, may flatten, and we may give weight, such as they evidently deserve, to other domestic iron ore resources.

That leaner ores will be used no one doubts, in fact ores are now shipped from the Lake Superior region which for years were considered undesirable, but with improved mining, transportation and smelting methods, the actual cost of producing steel is not advanced, and it is probable that some leaner or less desirable ores could now be used advantageously and economically in place of ore brought from the Lake Superior region. While the draft upon the mines has been tremendous, apparently threatening exhaustion, new finds are constantly reported. Minnesota, the largest producer, has developed ore bodies beyond the Mississippi River, and in the older districts of the Lake Superior region new discoveries are not unusual.

The Lake Superior region is the most productive, but not the only source of domestic ore supply. The Southern states have reserves which will permit them to continue producing iron and steel in competition. Late developments in concentration in Northern New York demonstrate that a liberal supply of rich ore may be depended upon, and that state, as well as New Jersey and Pennsylvania, offer possibilities in iron ores, which, although requiring beneficiation, may be mined, treated and smelted, at expenditures that will make them competitors with Lake Superior ores.

As far as iron ore is concerned, the western portion of the

Continental United States has been but imperfectly explored, but in Wyoming, Colorado and New Mexico exploited deposits maintain an iron and steel industry approximating in capacity the product of Sweden, and show large reserves of available mineral.

The abundance of our minerals, the comparatively low cost at which they can be obtained and transported, and the high rate of labor which has prevailed in this country, have retarded the introduction of many economies, but in the iron industry wasteful methods have been modified, ores formerly refused are utilized, advances in metallurgy reduce the fuel and labor cost per ton of metal produced, and an effort to conserve resources is growing in appreciation.

Considered merely as an iron yielding material for a manufacturing industry, the possibilities of a foreign ore supply might be mentioned, but this discussion refers entirely to national resources.

For the past 10 years the average annual increase in pig-iron production has nearly equalled the production of the metal with mineral fuel in 1876, and as in the 30 years under consideration the railroad mileage of the country quadrupled, while the average business carried on per mile of road is greatly in excess of earlier years, the demands for iron and steel correspondingly augmented. If progress in other lines of industry is traced, similar results may be expected, and it is therefore not surprising to find that the statement made by the President could be amended, and that in late years we are annually augmenting the production, not only of coal but of other materials, at a rate greater than the entire country demanded in 1876.

With an advancing civilization, progressive industries, augmented wealth, and increased population, greater demands upon our mineral resources are to be expected. These are evidences of national development, and the problem presented to the people is not the use, but the abuse of the available resources. If the consumption of coal required per ton of freight or per passenger hauled per mile on the railroads, or if the amount necessary to make a ton of pig-iron or steel products, or to produce 100 horse power by prime movers, had been the same in 1907 as it was in 1876, the increase shown in that year over the previous one would be much greater than the total output in 1876.

In the absence of the advances in metallurgy and improvement in mechanical appliances, progress in iron and steel manufacture, in other industries and in transportation details would have been impossible. The country could not prosper as it does to-day if prices of manufactured articles or costs of transportation were on the basis of 30 years ago.

Similar advances in other mineral products could supplement those of coal and iron, but we may pass to another resource.

FORESTS.

As an earnest forestry enthusiast, I do not minimize the destructive waste and reckless carelessness which have prevailed, and which are now far too evident in the condition of our forests, but it seems no more equitable to base conclusions on the past as to forestry than in the mineral products indicated.

Awakening public interest in forestry has been a self-imposed duty for more than a score of years, and while gratifying results are noted, it must be admitted that the value of trees and of forests is not generally appreciated. If the opposite were true the citizens of Philadelphia would revolt against the vandalism which last month permitted the sidewalk trees, struggling for existence between asphalt driveway and pavement, to be maimed and damaged by the erection of temporary stands from which to view street parades. Residents of suburban communities would protest against the destruction of rows of valuable trees to straighten sidewalks or make room for hedges, and the people of the state would be interested in forest fire legislation, and urge a basis of taxation which would not discourage the maintenance of forests by land owners.

The carelessness, which causes most of our forest fires, and the recklessness with which trees are felled or damaged to accommodate overhead wires or other improvements, are additional instances of inadequate appreciation. But a steady advance has been made in two decades, and no state equals our own in progressive forestry.

Substitutions for wood, which have been necessitated, may be expected to increase, and investigations carried on by railroad companies and steel industries will ultimately develop satisfactory substitutes for the timber tie, but some progressive

roads have established nurseries to grow trees for ties. Steel buildings, cars and bridges and structures into which reinforced concrete enter, aid in reducing the demands on the forests, but increasing population and diversified industries necessitate economies in the uses of wood.

The United States Government, with wise foresight, has set aside large areas of forest reserves, aggregating a total of 165,000,000 acres. Nine states have supplemented this with reservations amounting to 2,000,000 acres, and other additions will be made by national, state, corporation and private reserves. The proper care of these will extend the limits of our wood supply, and if the Government and various states add to these areas and protect and utilize them, the predicted timber famine will be further removed.

We may be proud of Pennsylvania's record in forest preservation, especially for the decade closing with the present year, during which it has accumulated, by actual purchase, more than three-quarters of a million acres of land, which are being administered in a practical conservative manner. These three-quarters of a million acres have cost the state, including contingencies and other expenses, \$2,345,400, or about \$3.00 per acre.

The Forest Academy, maintained by the state, is a unique institution, there being no other of this class, and its advantages will be increased from year to year. In addition to the Forest Academy, the State College has established a Forestry Department, and the Summer Forest School of Yale University is located at Milford, while some High Schools give instruction in forestry, and Arbor Day celebrations by Proclamation of the Governor each spring, and by the announcement of the Superintendent of Public Instruction each fall, show that forest education is not neglected.

The establishment of sanatoria for the care of citizens suffering from tuberculosis has also developed a valuable feature of the forest reserves, and it may be expected that under the care of the Department of Health, which received for this purpose an initial appropriation of \$600,000, the number and efficiency of these will increase.

We shall soon utilize much of our forest waste, and while we may not follow the economic methods of Central Europe, where small wood is fagoted for fuel, or of Sweden, where saw-dust

and lumber refuse are converted into gas for producing steel by the open-hearth process, we may anticipate more liberal application of the waste resulting in felling timber and producing lumber.

True conservation of our forests is not to follow the lead of New York, whose extensive reserves, the largest of any state, are held so as to interdict any use, but is better represented by the forest policy of Pennsylvania, which gives power to its Forestry Reservation Commission to administer state forests so that trees which may be cut when matured are replaced by forests which are propagated and protected.

While lumbering operations, bark peeling, turpentine tapping, charcoal burning, the preparation of logs for wood pulp manufacture, and other drains upon the forests have been and are wasteful, they have furnished products of value; and in some localities efforts at reforestation have been made. In fact some of the most valuable tracts of Pennsylvania forest reserves are the wooded lands maintained by blast furnaces, which produced iron with charcoal.

Probably more of our forests have been wasted by fire than by all other means, and fire often makes tree reproduction difficult, if not impossible. The urban population represents a large percentage of the total, and those who live in cities and large communities have little appreciation of the terrific destruction caused by forest fires, until the press records disasters such as ravaged portions of our own country and Canada a short time since, laying towns in ashes and causing loss of life and property, or until our Forest Commission reports that in 1908 forest fires burned over 850,000 acres in Pennsylvania. We fail to realize that a forest fire is not merely a monetary loss to the land owner, but that it depletes a resource, which, although capable of reproduction under judicious management, requires at least a generation for this process.

By protecting our forests from destruction, by making provision for combating fire, and by visiting punishment upon those responsible, we may minimize the damage from this source. But true conservation also demands care in the utilization of our forests, continued efforts toward reforestation, and the adjustment of taxation upon wooded lands so that their maintenance will be encouraged.

The prophecy of timber shortage, made by the head of a great railroad system which had in its construction and maintenance caused the denudation of vast forested areas, is to be viewed in the light of the forest reserves established, the legislation concerning the protection of these and the maintenance of tree nurseries and the improvement cuttings which are being carried forward.

WATER.

Water is a natural resource, the proper conservation and economical utilization of which will add greatly to the wealth of the nation, but except in the arid and semi-arid sections of the country its importance is not appreciated, until drought limits the supply or freshets damage property. The year 1908 has been remarkable for the duration of drought and severity of freshets in Pennsylvania, and public attention has been directed to the necessity of ameliorating these extreme conditions to the extent which man is able to combat natural forces.

It is not assumed that floods or droughts can be prevented. A proper proportion of forest cover maintained and protected on various drainage basins will hold back much of the storm waters in a saturated humus formed from the accumulated leaf waste of years, and give this off slowly, sustaining stream flow when the rainfall is insufficient. But the wood's floor or humus does not and cannot absorb the entire precipitation of heavy or protracted storms and rapid melting of snow or ice, and at such times an uncontrollable run-off of temporary duration results.

In this state extreme flood in many streams is 1,000 times the volume of the minimum low water discharge, and the problem of equalizing stream flow is a difficult one.

Reservoirs of large capacity are of marked service in steadying stream flow by impounding a part of storm water, and so delivering this as to increase the discharge when insufficient rain reduces the streams below normal limits. But the expense of such structures is generally great, and their capacity must be gauged by an outlay warranted by the results attained. Storage must also be based upon average years, for the construction of impounding reservoirs which are only filled in times of abnormal rainfall can seldom be approved. Consequently, the judicious maintenance and distribution of forest cover and the creation

of storage reservoirs ameliorate, but will not necessarily prevent the damage or inconvenience from freshet or drought.

Storage for public supply seldom approximates that required for irrigation, for power or for transportation, as the conservation of sufficient volumes to maintain a power plant at a capacity equated to normal stream flow, or afford navigation during droughts, or nourish otherwise arid soil, requires enormous amounts of water held in reserve.

The steadying of stream flow may tide over many times of limited discharge, and materially diminish the frequency and intensity of floods, making our brooks, creeks and rivers more available as means of water supplies, of greater value for irrigation problems or for the development of water power, and improving such portions of the streams as are navigable, or which can be made so, for the soil waste resulting from torrential or continued excessive rainfall finds lodgement in stream beds, thus doing double damage.

Conservation of water as a resource includes the development of our waterways as transportation media, and it is questionable whether the nation has not suffered by the anxiety to develop railways while neglecting river improvements and by permitting existing canals to be abandoned.

While the national, state and municipal governments have made liberal appropriations for harbor and river improvements, the aggregate outlay for what may be termed Continental America is not great when considered as affecting an area of 3,000,000 square miles, with 4,000 miles of coast washed by two oceans and the Gulf of Mexico, and a lake system 1,400 miles in length.

We are far from reaping full benefit from our 25,000 miles of navigable streams, and obtain no value from equal mileage subject to possible improvement, for in the United States there are but 2,000 miles of canal.

Great Britain maintains 4,000 miles of canals and improved rivers.

France has 3,600 miles of canals and 4,000 miles of navigable rivers.

Germany maintains canals whose total length exceeds those of the United States.

The possibilities of canalizing rivers, improving their depth and cross sections, constructing coastal deep waterways, are all

features of conservation and utilization of water as a natural resource.

We have a number of hydraulic power installations, and important irrigation problems have been met, but we are far from utilizing the possibilities of our streams.

To give some idea of the potential value of the water as power, we may consider our own state with an area of 45,126 square miles, and a topography ranging from sea level to 2,800 feet above that datum, the average elevation probably approximating 1,000 feet. On this area there is an average annual rainfall of about 42 inches. Assuming that with a fair amount of impounding capacity, one-half of this rainfall could be utilized for developing power, and that the topographical conditions admit of the utilization of one-half the averaged elevation upon sea level for water power improvements, the precipitation upon the area of Pennsylvania during a year of average rainfall, would be sufficient to develop with good water-wheels 3,000,000 horse power continuously, or if this water were applied to hydro-electric units of approved construction, 2,000,000 kilowatts continuously.

This merely indicates theoretical possibilities, but although apparently liberal allowances have been made in the proportion of rainfall available and in the fall utilized, other conditions interfere with practical development. The construction of railroads has generally followed watercourses; communities have grown up and industries have been built along the banks of streams, and often the best arable lands are in the meadows adjacent to stream beds; thus apparently possible sites for water-power improvements are not available, except at extravagant outlay for damages, and by overcoming serious opposition from vested rights. In the mountainous section the fall per mile is greater, but the volume of the stream is less than in the lower reaches, and numerous locations, which at first sight appear desirable, will not offer sufficient power to warrant an installation of equipment and the conveyance of the current generated to distant points.

The application of water for power does not consume, but merely utilizes this fluid in transit, but the necessity on most streams of providing storage to equalize the flow, and the diminished fuel consumption by reason of the power produced,

place the improvement of water powers among the features of conservation.

Our water-supply systems are extensive, a number of them exceptionally good, and improvements are constantly being made, but during the past months many communities have suffered from scanty supply, which emphasizes the necessity of conservation. Sewage disposal and garbage utilization plants are also increasing.

A feature of practical conservation of water for municipal use is the leakage in reservoirs and distribution systems. The pipe lines in the streets of Philadelphia have probably 700,000 joints and over a quarter of a million house and factory connections, and perfection is not to be expected. The millions of joints, faucets, etc., in the buildings assist to swell the opportunities for leakage, and true conservation suggests that a municipality's duty is to maintain its pumps, reservoirs and distributing system as free from leaks as possible, and for the manufacturer or householder to prevent all loss of water practicable.

With these deficiencies corrected as far as can be done, and unnecessary loss prevented, it may not be necessary to estimate for water supplies based upon a daily consumption of 250 to 300 gallons per inhabitant.

The proper conservation and utilization of water also prohibits its unnecessary befoulment, and suggests that we get away from the notion that streams are to be the media of removing all that we consider undesirable. We are not justified in fouling streams because water may be artificially purified by various filtration processes.

I am not sufficiently optimistic to anticipate that mining and manufacturing industries will retain or utilize all refuse and waste, or that all sewage will be disposed; but I believe that conditions which are now detrimental may be much improved without submitting important industries to serious hardships, or interfering with the development of communities.

CONCLUSIONS.

Our minerals as natural resources must be won from the earth by mines and through shafts, drifts and tunnels, or by enormous excavations, bringing into play the best efforts of a progressive educated people.

To win a few ounces of gold tons of material must be handled, and other metals are found in such chemical composition that intricate treatment, or beneficiation, is necessary to make them serviceable.

Coal is a natural resource, but must be dug from deep mines, passed through breakers and washers, and a large portion converted into coke, for use in smelting iron ores to produce the pig-iron which has done so much to place the United States in a prominent position among the nations of the world.

Forests are natural resources, but their utilization demands the axe, saw and mill, the handicraft of the carpenter to fabricate the wood into usable form, and the intelligent foresight and care of the forester.

Water is a natural resource, as springs, rivulets, brooks, creeks, rivers or oceans. In the small volumes it supplies a necessity for our existence, in larger streams it becomes a medium of transportation, and as a source for power or for irrigation volume and fall are considered. Water can be used as a means of transportation only so far as there are no obstructions for vessels, but where this is extended, man's services are required in dredging channels, constructing jetties, building canals, locks, and making navigation safe by break-waters and light-houses.

Water may be free to all, but to supply a community, or irrigate land, or develop hydraulic power, man must build dams, ditches, reservoirs, lay pipe-lines or conduits, and erect machinery; much of our engineering knowledge and ability being devoted to a continual contest with water, either in combating it or controlling it.

Conservation of natural resources will result from calm consideration of their extent, character and possibilities, for the variety and amount at our command are blessings to be appreciated by utilizing and conserving them, and we deserve to fail as a nation if we are careless concerning these features.

But true conservation is not advanced by scare heads announcing the exhaustion of our minerals, the length of time our timber will last, the depletion of our water resources, the destruction of our soils, and like dire prognostications. It is more patriotic to recognize that our national development is the result of using the resources with which God has endowed us, and to treat them as a trust, administered so that we and those who follow us will get the most good from them.

The man who plants trees is a better friend of forestry than one whose enthusiasm consists of quoting "Woodman, spare that tree."

He who converts any waste product to a useful purpose is a better conservator of resources than one who, viewing merely the quantities used, prophesies national decline.

Conservation is now popular; to have it continue so we need to study our resources as aids to progress and means for future prosperity. It must be recognized as a serious problem for the people and not as a fad of a bureaucratic coterie. The active coöperation of the brain and brawn of the country is essential to secure the conservation and utilization of our national resources, thus maintaining and perpetuating the United States as foremost among nations.

CEMENT AS A SUBSTITUTE FOR WOOD.

PROBABLE EFFECT ON LUMBER PRICES.

The relation between the increasing use of cement and the diminishing timber supply in the United States has been the subject of some interesting correspondence between the Geological Survey and the Forest Service at Washington. In a letter to the Forester, the Director of the Survey took occasion to quote from a statement of a large Philadelphia firm to the effect that it would be difficult to estimate what the additional drain on the lumber supply would have been during the last few years had not cement come into such general use. The Forester replied in part as follows:

"The Forest Service is watching with a great deal of interest the increasing use of cement and other substitutes for wood. They are undoubtedly having some influence on the price of lumber, though I do not think that up to the present time they have greatly retarded the advance in lumber prices. The fact is that our industrial progress has been so great that our requirements for every kind of structural material have increased tremendously. We are using at the present time more lumber per capita than ever before, and probably twice as much per capita as we did fifty years ago. The conclusion cannot be escaped, therefore, that in the future we must depend more than in the past on other materials than wood for certain purposes at least. As to the increase that will take place in the production of cement, my impression is that this will be very great."

If the increase in the use of cement in the United States in past years is to be regarded as any index to its future use, the conclusions of the Forester are well founded. The statistics of the production of minerals show that our output of cement has more than doubled in the last five years, and it is well known that its use is being very widely extended. This is due to two conditions: In the first place, excellent cement materials are common in almost all sections of the country; in the second place, reinforced concrete for heavy building material is receiving increased favor among engineers, while in the country regions large amounts of cement are being used for building blocks for smaller structures. Reports received by the Survey during the six years from 1902 to 1907 show that the production of cement in the United States has increased from 25,000,000 barrels, valued at approximately \$25,000,000, to 51,000,000 barrels, valued at \$55,000,000, the annual statistics showing a steady increase in production with some slight fluctuations in price.