ABSTRACT

Energy and other materials scarcities/shortages are the inevitable outcomes of the developmental processes. Therefore, we must have to learn how to do our planning and policy making subject to physical constraints—energy and other natural resources. It calls for a new and different kind of public policy. In a sense, this paper pleads for **a paradigm shift** in policy-making processes. Mere empty slogans and target-fixing do not as also should not make public policies.

Development is essentially built upon an ever depleting resource-base because development means extraction and extraction means depletion. Resources are finite and non-replenishable. Therefore, the fact of the matter is that **growth contains decay** or in growth lies decay. Depletion and decay are, by nature, inherent in the mining sector. The cognizance of this awesome reality constrains policy-making machinery to consider sustainability as its core instead of periphery as is the case now.

(N NAGANNA)

INTRODUCTION

The recently held (October 16-19,2000) workshop on "Public Expenditure Management" at IIM-Bangalore, prompted me to take up the writing of this working paper. As a matter of fact, the ideation for this paper came from my on-going study/project on **"Exploration, Mineral Resources and Public Policy"** funded by the Training Division of the HRD Ministry, GOI, to prepare **a case study** for the classroom discussions in the IAS training programmes.

The present working paper is broadly divided into three parts as below:

⇒ Part-I deals with **"Public Expenditure Programmes, Natural Resources and Public Policy : A New Perspective on policy design".**

⇒ Part-II is concerned with the **"Resources Analysis"**, and the processes associated with the assessment of (future) materials availability/supply potential to meet the expanding demands of policy making; and

⇒ Part-III deals with the **"Empirical Assessment of Resource base – Some Illustrations".** It is addressed to examine and analyze the issue of slaughter-mining practices through some practical illustrations, and the need for state intervention to implement the stringent conservation policies.

All these three parts together are hoped to give a new perspective on policy design. The present paper focuses mainly on the non-renewable mineral resources because the problems posed by the renewable resources like the forestry, fishery, soil fertility etc., are however totally different, requiring a different type of analysis and treatment. This is a drawback in this paper. The present policy-making exercises are found to be lopsided. The need is for a balanced approach. The present paper is an attempt in that direction. The paper argues that the public policy-making requires to take explicitly into account the **resources analysis** or the supply-side management instead of totally relying on the demand-side. Then only the public policies will be more meaningful, effective and fruitful.

Energy and other materials scarcities/shortages are the inevitable outcomes of the developmental processes. Therefore, we must have to learn how to do our planning and policy making subject to physical constraints---energy and other natural resources. It calls for a new and different kind of public policy. In a sense, this paper pleads for **a paradigm shift** in policy-making processes. Mere empty slogans and target--fixing do not as also should not make public policies.

Development is essentially built upon an ever depleting resource-base because development means extraction and extraction means depletion. Resources are finite and non-replenishable. Therefore, the fact of the matter is that **growth contains decay** or in growth lies decay. Depletion and decay are, by nature, inherent in the mining sector. The cognizance of this awesome reality constrains policy-making machinery to consider sustainability as its core instead of periphery as is the case now.

N Naganna

PART – I

Public Expenditure Programmes, Natural Resources & Public Policy

- A New Perspective on Policy Design

PUBLIC EXPENDITURE PROGRAMS, NATURAL RESOURCES AND PUBLIC POLICY*

(A New Perspective on Policy Design)

N Naganna

It may be noted that all the public expenditure programmes in any form and in any place, will have definite and certain impacts on natural resources, particularly more so, on the non-renewable/non-replenishable stock of natural resources. Because, all such programmes are, in effect and in the ultimate analysis, are mainly geared towards **"altering and using"** the natural resource-base to satisfy the human needs and demands whether they are reasonable or otherwise. In other words, the objective of public expenditure programs is to unleash, promote and maintain the forces/drivers of growth in a geographical setting may be called a district, a state or a nation. In turn, the motors of growth thus unleashed by the public expenditure programmes are envisaged to undertake the economic development programmes which, in turn, take up the programmes of commoditification of natural resources All these processes are meant to improve the living standards or social welfare.

Public expenditure programmes on the one hand consume natural resources (i.e., materials) directly as also facilitate the increasing levels of materials consumption indirectly by injecting several kinds of growth impulses into the economy, on the other. In either case, the result will be more exploitation of natural resources than before Spending implies a transfer of entitlement over goods and services while saving implies deferred consumption. In any case, public spending increase the use of resources either in the short or long run. (See, Tables 4a and 4b)

Since development is essentially a physical phenomenon, its central thrust is the commoditification of natural resources. This being the case, the public expenditure programmes need to take into account explicitly the extent and quality of natural endowments of natural resources, particularly the non-renewable ones. Thus comes the critical issue of **sustainability** or the **carrying capacity** of the physical resource base to the fore in matters relating to the public expenditure or public policy programmes [1] The issue of sustainability mainly refers to the long term phenomena and the inter-generational equity and justice in terms of the exploitation of natural endowments. Its concern is on the un-born posterity who is not present in the current decision-making. The criticalities of sustainability and the issue of compatibility between the higher rates of growth and its sustainability have been dealt with extensively in Naganna (2000).

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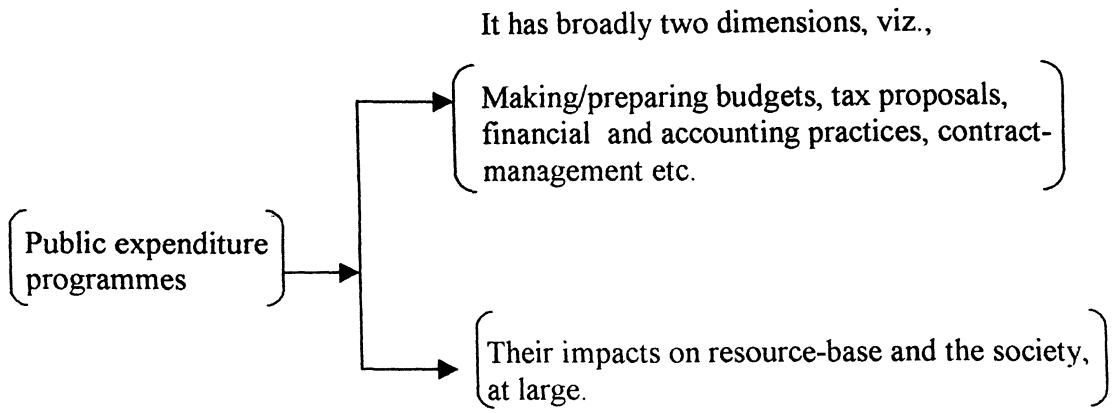
* This note is a part of an on-going study on **"Exploration, Mineral Resources and Public Policy" funded by the Training Division of the ministry of HRD. GOI.**

[1] N Naganna. **"Elements of Public Policy Analysis"** (Vol I. specially prepared for IAS Training programmes on **Public Policy**. IIM-B. mimeographed)

In effect, the public expenditure programs (or public spending) increase the consumption levels either directly or indirectly; or in a sense, promote consumerism in society. Can this hyper prosperity be sustainable? Since high rates of growth means high levels of consumption, the issue then becomes one of sustainable consumption within the parameters of the known and potential resource base. In fact, this has been addressed in Naganna (2000).

Public Expenditure Management:



The concern of the present Note is mainly on the impacts of public expenditure programmes on the resource-base and the society, at large. The public expenditure programmes are the outcomes of public-policy making and an inseparable part of the implementation strategy. Based on the Keynesian approach, the public policy making at present centres around mainly the budgets, taxes, monetary and fiscal mechanisms, in which scheme of things, the resource-base does not enter at all; and if it enters, it enters last, not first. In other words, it centres around demand-side or demand management. The present Note pleads for a tilt towards supply-side or a judicious blend of the two, instead of exclusively concentrating on the demand-side management. In such a scheme, the following elements, besides the conventional ones, enter explicitly and thus make public expenditure programmes more meaningful, sustainable and effective.

a. The impacts on the present state of environment which is BALDED.[2]
b. Impacts on physical resource base.
c. Material surveys to assess the supply potential before the public expenditure programmes are drawn.
d. Public policy-making to be endogenous to the social system and not exogenously modeled.
e. Environmental auditing and Natural Resources accounting to be made as integral parts of public expenditure management.

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[2] It is an acronym coined to describe the current state of environment in India, where : B= Billion lot (population explosion, demographic features etc.,); A =increasing levels of aspirations leading or resulting in higher material-intensive and energy-intensive life styles; L= life expectancy; D= deforestation; E= effluents (or wastes) of all types from extraction, production and consumption streams; and D= depletion of natural resources.

These elements are essentially complementary to the principles of public expenditure management. The present Note is not, however intended to remind the **dooms-day** messages but to achieve **sustainability** or the sustainable development while coping fairly adequately with the material requirements of higher rates of growth to improve the living standards of the people.

Sustainable-development: In this context, a digression on **"sustainable development"** is called for (See, Naganna, 2000 and David Novick, 1976). This concept, though deceptively simple, is evolved over a period of time to become a **guiding-principle** in all the developmental programmes across all the sectors of the economy in India.[3] In simple terms, it advocates that the governments will have to **develop and use** their natural resources in a manner which is sustainable. Though the concept of "sustainable-development" is extensively used in almost all the debates, its meaning in practice remains unclear (See, Naganna, 2000). In fact, it refers to many a phenomena, each representing a particular perspective, such as:

a) It refers to the social commitment to preserve natural resources for the benefit of the present and future generations.

b) At times, it also refers to some appropriate standards or guidelines for the exploitation of natural resources based on the extent of natural endowments and the harvests or use. Here, the term **"harvest or use"** is supposed to embrace the laudable adjectives such as : "sustainable", "prudent", "efficient", "rational", "wise", or "parsimonious" or "appropriate".

c) In some instances, sustainable-development implies or refers to an **"equitable"** use of natural resources, suggesting thereby that the use by any country must take account of the needs of other countries and people. The lavish consumption of world's natural resources by the USA is a case in point (See, David Novick, 1976, p11). Thus, the principle of "equity & justice" becomes an added dimension to sustainable-development both across the countries and the present and future generations.

d) Yet another dimension is added in recent years to the concept of sustainable-development. Since the natural resources are an integral part of environment, the sustainable development requires that the environmental considerations be integrated into the economic and other developmental plans, programmes, projects and policies. While at the same time, the developmental needs are also to be taken into account explicitly in applying and complying with the environmental objectives. This makes the sustainable-development a more complex process.

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[3] See, The India's Seventh Five Year Plan document (chapter on Environment). Later, the Eight Plan document broadened the base of economic planning by suggesting to include the **efficient use of resources and long term sustainability**. In fact, these guidelines should be more imperative than indicative as the case seem to be now

As a matter of fact, all these four seemingly different aspects/perspectives together constitute the broad concept of sustainable-development. They are inseparable and in fact, interdependent elements. From these elements, one has to derive the broad guidelines for development and the use of natural resources. And, these guidelines need to be more imperative than indicative as the case now is. This being the case, the primacy of resource-base over developmental-objectives takes place in policy formulation. In other words, the resource-base enters first, not last as the case is now and thereafter, the developmental plans emerge. Consequently, the very objective of public policy gets enlarged. It is not merely achieving development to improve the living standards of the people but to achieve sustainable-development as described above. Accordingly, the policy-design becomes a highly complex frame encompassing, among other things, the newly added aspects like the resource analysis & evaluation, exploration, stringent conservation and resource-pricing reflecting the scarcity-value and social costs. This has to be kept in mind while formulating public policies.[4]

Resource-base: The public expenditure programmes, in effect, give more money to people to buy more goods and services. In turn, the manufacturing firms produce more goods to satisfy demand. This means more employment and perhaps, higher wages. The newly employed have more money to spend or save (Saving is deferred consumption). In either case, more production is called for; and the economy grows and **more non-renewable resources are used**. This is how the resource-base enters explicitly in public policy making. The policy formulation without a due consideration on the endowed resource-base is like the setting of goals without specifying means. It is just an empty slogan.

Earth takes several millions of years to get a mineral/ore formed in its crust through various lengthy and complex geo-chemical processes. Such a valuable stuff has to be used with utmost caution. The state of reckless extraction, production and lavish consumption is indeed an unpardonable crime on resources and the posterity.

This aside, the onset of energy crisis in early 1970's gave rise to a new awareness of the importance of mineral resources all through the world, particularly in the western countries. However, the response in India is lukewarm. Most people are inclined to think that a similar shortfall in the supply of other minerals may develop soon This sentiment is giving rise to more rational use of minerals, to more recycling and recovery of metals and to the development of substitutes to some of the scarce minerals to make the resource base more sustainable. But the trend is not on a scale as warranted by the occasion. Because the public still think that the minerals are readily available when needed. This mind set needs to be changed.

In what follows is a list of some of the observations/statements made on natural resources and public policy in literature(including my own) which taken together will give a new perspective on policy-design. Most of the statements are simple and self-

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[4] Shenggen Fan, Peter Hazell, & SK Thorat, "Impact of Public Expenditure on Poverty in Rural India **Economic and Political Weekly**, September 30, 2000, pp 3581-3588

explanatory but have profound implications both in formulation and implementation of public policy. A word of caution needs to be given here. These observations need to be considered in a holistic manner rather than in isolation. What comes out of these observations is that there is an imperative need to provide due space for exploration, conservation and mineral resources in public policy making.

Some Observations/Statements[5] on Natural Resources & Public Policy:

1. The shortage is really in man's ideas and planning rather than the physical limits of the non-renewable resources of our globe.

2. There are finite limits to natural resources. Man, however, is capable of continuously extending these supplies by appropriate application of technology, economics and politics.
3. It is well within man's powers to both reduce material demand and increase supply from the existing stock of natural resources.

   * It calls for a **new** and **different kind** of public policy.

4. Resource analysis must be in today's debate about tomorrow's world. "Resources are not.... They become". "Man's own wisdom is his premier resource....the key resource that unlocks the universe".

5. All countries have more goods per capita than ever before. Sustainability?

⇒ Development of substitutes, Recycling and Recovery, S & T etc., should not be used to rationalise and justify the current levels of lavish, reckless and wasteful consumption.

   * Nothing comes free of cost. Everything has a price. All discoveries have a price.

   The dramatic escalation in crude oil prices **intensified** the economic problems of raw materials. Materials cost gone up.

6. To enlist people, business and government into doing something to insure adequate supplies of raw materials for a growth economy which is sustainable.

7. Up to now, we operated on the **assumption** that there was an **unlimited** supply not only of energy but also of all natural resources. This is proved to be **wrong.** ..... The unprecedented prosperity showed that we had reached a point in time when

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[5]See. the classic work of David Novick. **"A World of scarcities : Critical Issues in Public Policy"** (Associated Business Programmes, London, 1976). In fact, many of the statements are drawn from this seminal work. See also, N Naganna "Economic Reforms and Sustainability : A Conceptual analysis and framework". **The Indian Journal of Economics,** No.318, vol. Lxxx, January 2000, pp. 355-394. Another landmark in the resources analysis is the classic study on **"Limits to Growth"** (MIT, USA, 1971).

nature's bounty no longer could be taken for granted, and those ideas about economic growth would have to be **re-examined.**

⇒ Man was making problems and not doing anything about them.

8. Phenomenal rates of growth had meant **using up** mineral, timber, fiber and food resources much more rapidly than additional sources of supply were being developed.

   * We neglected the implications and meaning of industry's **ever-increasing appetite** for fuel and raw materials.

9. **Money alone** can not produce "instant natural resources supply". The sharp increase in the price of oil accelerated the petroleum exploration and development by using new techniques like electronic sensors, computerised systems etc. Similar developments can take place for other minerals. That way, 'man can solve his problems'. But it takes time. It takes a long time for natural resource expansion. Therefore, plan for the future before the crisis is upon us.

10. Up to now, the government planning has been concerned largely with the problems of demand. Policy decisions were based on expenditure surveys, programme budgets and plans. The decisions and actions were essentially short term.

⇒ There is just no way to handle the physical limitations on supply side in our current concept of economic management through monetary and fiscal policy. The Keynesian approach put the emphasis on managing demand.

⇒ Higher rates of growth or the high levels of consumption can be made sustainable only through exploration and conservation programs on a continuing basis.

⇒ Consumption, welfare and standard of living are to be re-examined and redefined in the context of resource-base resource flows and residual management.

11. Evaluating time, economic, political and environmental constraints in formulating public policy is a difficult task. We can not generalise in terms of budgets/money alone. **Instead, we must learn how to do our planning and policy-making subject to the physical constraints – energy and other natural resources.**

⇒ The comfortable days are over, and we must now formulate public policy so as to maximise welfare **under entirely new conditions** (BALDED situation).

12. Probably the **first course of action** is to develop the goals of a materials policy and state them in terms everyone can understand

⇒ The overall goal requires programmes for **reducing** demand as well as **increasing supply** expressed in quantities and time schedules

This requires a comprehensive natural resources materials policy that includes the following:

a. Reduce demand by conservation, substitution, recycling and recovery, re-use and new technology to reduce material-intensities in products. Increase durability in products. Total discard of the concept of disposable products or the "use & throw" syndrome.

b. Increase supply through exploration, investments and new technology and better mining systems to increase the levels of recovery from the deposits.

c. Prepare for emergencies in materials scarcities.

d. Determine the management method (public or private sector or a combination).

13. We have to swallow a really bitter pill---reducing our standard of living (solution).

14. **Conservation:** has great potential and promise for cutting down demand.
Because: most products now in use were designed with the philosophy that materials are **abundant and cheap.**

a * Since natural resources were available for asking and the least costly of the factors of production, in the past there was no incentive to stress commodity savings.

* For a long time, major emphasis was on **labour-saving;** and this meant not only more and better machinery but also more wasteful use of materials. This reflected most notably through over-specification of products including packaging and throwaway instead of repair.

b. Thus, there is a tremendous opportunity for conservation of natural resources in practically every product in everyday use.

There is a substantial scope for conservation of materials use in all the public expenditure programs. Simple **"house-keeping"** measures alone can save or avoid sizeable amounts of materials wastages. Please, look at the **rotten** equipments lying idly for years together in all the PWD office compounds.

c. Consumption habits also developed in terms of the idea that materials are **cheap** and easily available. The modern concept of convenience was based on **disposal instead of re-use.** Re-use of products needs to be encouraged through the promotion of **Second-hand markets.**

d Whatever the reason, both consumers and producers have habits of making and using objects that place materials conservation at the bottom of their economic considerations

⇒ So, we have a large store of bad practices on which to draw our conservation rules.

⇒ There is a dire necessity for a **great movement** for conservation, which is more important than all other movements now before the people. Sustainable consumption demands this.

15. **Substitution:** can take a number of forms. We can replace the present activity with an entirely new one in which the kinds and quantities of materials used are drastically revised. Or substituting a more plentiful material for one in short supply.

a. Historically, growth or improved well being meant not only satisfying old wants but adding to the list of goods considered necessities. This trend has had a marked impact on the way in which we used natural resources.

b. The re-use of old material can take place in a number of forms including salvage, rework or recycle.

c. Wherever labour is plentiful and cheap, the opportunity to trade off labour for material arises.

d. The most critical shortages seemed to be aluminum, copper, rubber and steel. Substitutes and replacements were searched for intensively.

16. **New technology:** will ultimately provide the substitution, conservation, and reclaiming processes that will reduce new requirements for natural resources. Reduce the material-content of the products.

17. No country in the world is completely self sufficient through its natural endowments of non-renewable resources. These gives rise to policy questions on international relations and stockpile management methods. All of us are living on the same reserves of natural resources.

18. **Economic Growth Rates:** National policy on the use of natural resources in all countries has been a heritage from the era of **carefree abundance.** These calls for economic growth based on **lavish use** of the difficult-to-replace bounty of nature.

⇒ If we are to avoid an economic breakdown, we must face disagreeable facts, abandon old habits and make difficult choices to develop **national policy** appropriate for a world in which natural resources are **scarce and expensive** rather than abundant and cheap as they used to be.

⇒ We will have to re-examine that generally accepted national objective---economic growth

19. Economic development = physical phenomenon = produce more + distribute more + consume more
= conversion of natural resources into products
= commoditification of natural resources.

In any case, as the economy grows, more non-renewable resources are used. Higher rates of growth to improve the consumption-oriented living standards imply higher rates of exploitation of resource-base and this, in turn, imply faster rates of depletion, resulting in the awesome scarcities of materials supplies. The material and energy scarcities are normally reflected through pricing mechanism in higher proportions of energy and materials costs in total costs of manufacturing. Empirical evidence confirms this emerging trend (See, Table-4). This is in fact a disturbing trend because we can not take for granted that minerals will be available when required.[6] The days of plenty are no more.

20. The inter-relationship among population, GNP, materials and energy must be kept in mind in the formulation of policies for national economic growth for the future.

⇒ The essential program for large investments in energy and other natural resources expansion is the **ways out** for sustainable growth.

⇒ Public policy today should undertake to minimise and turn around depression forces by measures, which will provide employment, stimulate business and direct investment into the expansion of supplies of energy and other basic materials.

21. Scarcity obviously can be the result of either too small a supply or too great a demand. It is the result of the unlimited extent of man's material wants. Ultimately, there is a **limit** to both the earth's crust and its content of available material.

⇒ Improved techniques for processing low-grade ores can provide very large additional supplies. To that possibility, we can also add recycling of today's mineral wastes

⇒ Minerals at very deep depths (say 3 to 4 miles) from the earth's crust. Then, there is sea. Nature's bounty is sufficient to accommodate man's **reasonable** demands Then, there arises the question of defining the terms like demand, requirements, use, consumption and supply.

22. Really, there may not be scarcity in the foreseeable future. That does not mean that there will not be scarcities. These are man-made scarcities. They are the result of
a. too little planning, private and government
b. bad or unsatisfactory data, and

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[6] Ralph W Marsden (Ed)., **"Politics, Minerals and Survival"**, the University of Wisconsin Press. 1975 In this book (p 55), it has been observed that "Many of those persons who are concerned with minerals believe that their importance to man has not been fully appreciated by the consuming public" A lot of effort is therefore needed to educate the public on their consumption habits/patterns to promote the basic three R's – Reduce, Reuse & Recycle

c. the assumption that computer programmes, mathematical equations and statistics could be used as the **basis for policy in place of good data and good sense.**

⇒ We must take a new approach to managing the problems of scarce resources (solution)

23. Higher growth rates would mean scarcity.

⇒ Manufacturing the products necessary to maintain a rising standard of living for an increased population means that an expanding demand for basic materials must be met. Now, everyone believes, it is government duty to improve the standard of living of people; and somehow, no matter how, find the wherewithal to do it. This is a relatively new and different attitude. The governments have accepted this responsibility and thereafter, the government interference moved upward in scope and intensity. A new economic role for government is given particularly for economic growth, full employment, and social welfare. This is a new policy. And, all the governments have only one **tool** in common – the management of demand; and the single-minded use of fiscal and monetary policy for this purpose. It is only a bold way of saying, we really know very little about how to do the job.

⇒ The demand-management had produced **effective wants**, that is desire plus the money to satisfy it, in excess of goods available. And the failure to keep demand at manageable levels was equally the result of **unsatisfactory supply management**, or lack of management by business and government.

24. The good old days have been slipping away while we were enjoying our hyper prosperity. **We have moved from plenty to scarcity.**

25. Today in thinking of expansion programs, full employment, new plants or the design of a new turbine, too many of us blankly forget to look back to the **mine, the land, the forest:** the sources upon which we absolutely depend ..... **we think about materials resources last, not first.**

⇒ The people must be taught that the will of the planner is for their own good. A plan needs to be less than imperative but more than indicative.

26. High growth rates had meant using up mineral, timber and many other resources much **more rapidly than we were replacing** them. Thus, physical constraints arise on prosperity.

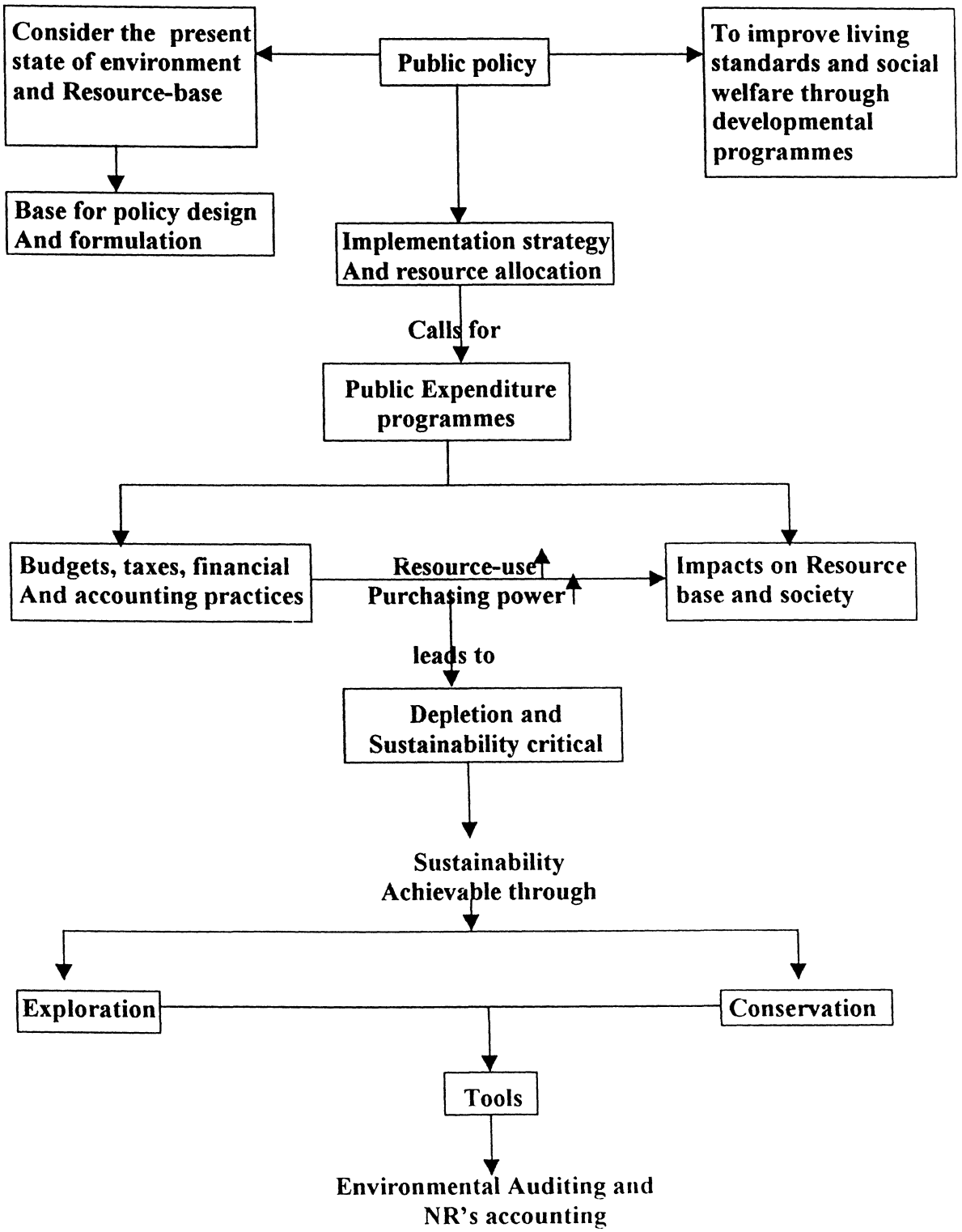
⇒ In the long run, progress in exploration will lead to the discovery of new supplies; technological advances will make more materials available from existing sources, and new inventions will create substitutes for or make unnecessary many of today's critical materials that are in short supply. (Solution).

⇒ There is only one reason for natural resource scarcity. That is, to formulate a positive policy and then take the action the policy calls for. That is exactly what we have not been doing, and many people believe strongly that it should not be done.

The analysis as carried out so far in this Note is presented in a flow chart-1 on the next page.

CHART-1

MAKING PUBLIC EXPENDITURE PROGRAMMES MORE EFFECTIVE AND SUSTAINABLE



Global Trends in Resource Exploitation:

Table-3 reveals some startling trends in the extent of exploitation (or depletion) of mineral resources in recent times. For instance, the value of mineral production as a proportion of GNP at the global level has increased substantially from a meager 4.82% in 1950 to as high as 9.88% in 1980 (See, Table-3). Our surmise is that this awesome trend might have continued still further to higher levels after the year 1980. This is the result of the unprecedented materials prosperity. It should be noted that we are talking about **proportions** and not absolute growth. In other words, the relative growth of the mining sector is faster than other sectors to maintain the super prosperity levels. This implies faster rates of depletion than ever before. Table-3 also indicates implicitly the extent of contribution to the resource-base made by substitutes, recycling and re-use because the percentage of metallic resources in total GNP remained stable at 1.2% of between the years 1970 and 1980. On the other hand, the percentage contribution of energy fuels to the total GNP reveals the scarcity value of resources and the impacts of cartelisation of resource suppliers/owners (See, Table-3). On the whole, the empirical evidence at the global level amply demonstrate the imperative need to re-examine the concepts of economic development and materials-driven living standards, keeping in view of depletion and waste (residuals) generation in the extraction-production-consumption stream (See, Chart-4 in Naganna, 2000). This Chart-4 clearly demonstrates that the waste generation on all fronts affects environment adversely and this environmental degradation in turn affects the social welfare/quality of life. In effect, this reiterates the need to re-examine the concepts of growth and consumption-driven standard of living.

Development as Commoditification of Natural Resources:

This needs a bit of explanation. In this context, the natural resources are to be broadly divided into two categories, viz., (a) Renewable resources like fishery, water, forestry, soil fertility etc., and (b) Non-renewable resources like the energy fuels, minerals etc. On general grounds, one can observe that the renewable resources normally ensure **human survival** and the development as we normally understand do not depend much on the renewable resources. In a sense, they can also be considered as **life support systems** though the economic growth does not depend much on them. Economic development is therefore essentially based on the non-renewable resources because the"not-needed-for-survival" type of commodities (i.e., economic development) are produced from the non-renewables like the fuel and non-fuel minerals. As a matter of fact, the economic development, from the resource base point of view, means the production of `not-needed-for-survival' type of goods or simply, the non-survival goods. And, these goods are labeled as necessities, comforts and luxuries etc., besides conspicuous/ostentaneous consumption of goods and services. That is why, the minerals are rightly called as the main spring of material civilisation and it is also said that the mankind's progress is measured in minerals. Therefore, from the resource-base point of view, economic development means the commoditification of non-fuel minerals by the fuel minerals (both non-renewables). So, the source of growth is the mining sector.

Such being the case, it must be recognised that development is essentially built upon a **continually depleting-base.** Therefore, the fact of the matter is that **growth contains decay** or in growth lies decay. The cognizance of this vital and awesome issue constrains the policy-making machinery to consider sustainability as its core instead of periphery as is the case now.[7] (See, Naganna, 2000).

It is also true that the commoditification process is taking place in recent times in the case of renewable resources also (e.g.: agri-processing, water, food-processing, forestry and fishery processing etc.). But this takes place only through the use and application of non-renewables like energy, metals, etc. Thus, development as a commoditification process refers mainly to the non-renewable resource endowments. On general grounds, it can broadly be said that **development lies in minerals (both fuel & non-fuel) while the human survival lies in renewable resources.**

In the same vein, one more simple fact may be noticed. That is, from the resources view point, development means more production/consumption; and in turn, more production/consumption means generation of more wastes (or more residualisation) on all fronts, viz., extraction-manufacturing-consumption streams.[8] (See also, Chart-4 in Naganna, 2000). To sloganise, this is to say that : **"Today's production is tomorrow's waste".** Because, we don't consume anything; but we use and discard. It has been observed that the waste generation in recent times normally goes beyond the assimilative capacity of environment and thereby, results in environmental degradation which, in turn, adversely affect the social welfare/quality of life.

Now, it is clear what development means. It is in this context that we have to re-examine the public policy objectives of achieving growth, consumption/living standards and production.

Public/Social Choice: In the context of re-examining the developmental processes in general, the following issues, among others, need to be addressed from the resource-availability point of view. Then only the exercises in policy formulation will be more realistic and meaningful. At the outset, it may be said that the developmental processes at all stages need to be integrated fully with conservation. The proposed new paradigm requires a social/public choice on all these matters through aggressive advocacy. In this context, the following few broad policy choices have been identified. They are:

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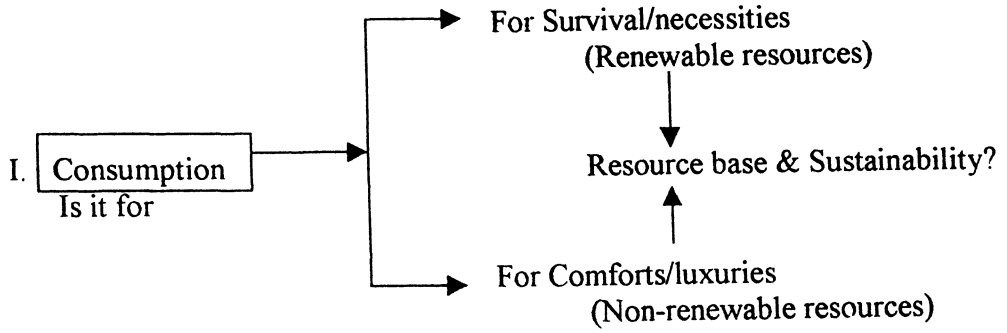
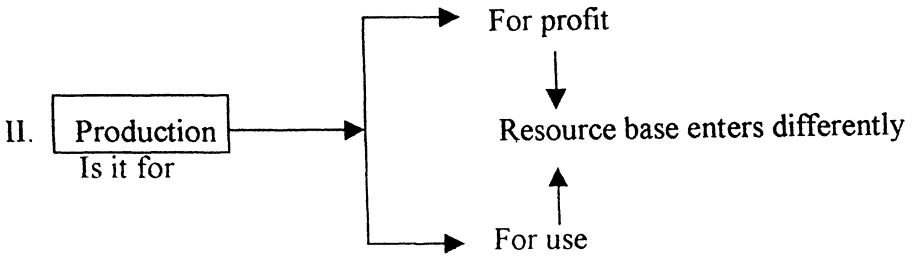
[7] My effort here is not to plead for a case of 'going back to nature' or the pre-historic stage but to advocate development with utmost caution that attacks reckless consumption and slaughtering of resource base.

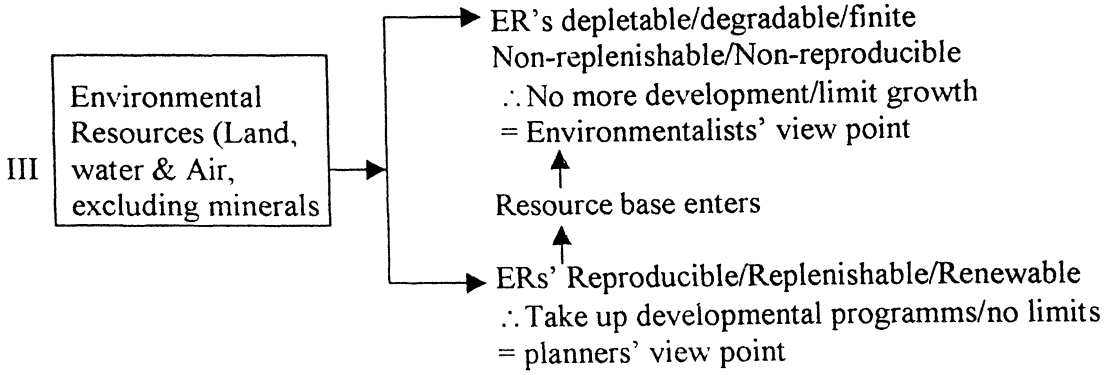
[8] Allen V Knnese, **"Economics and Environment : A Materials Balance Approach"**, Harmonds Worth, Penguin, 1977. In the context of public policy and natural resources, see, T Curtin and J Jones. **"Managing Green Issues"**, Macmillan Press Ltd., 2000.



Note: The unrealistic assumption that the resources will be available in plenty for ever and at cheaper prices led to the reckless consumption patterns. This needs to be checked There is no way. Recycling of all wastes & other residues, Reuse, product-durability in place of `use & throw', dematerialisation of products including packaging, or reduce the over-specification of products, substitution of scarce by abundant resources, reduction in avoidable consumption, conservation on all fronts, etc., are to be encouraged and promoted



Note: This is an old controversy [9] However, resource-base enters differently under the two different situations This needs a wider debate from the resources and sustainability view point



Note: This is the striking controversy present in almost all the debates concerning the issue on **`Development vs. Environment'.** There is no agreement on this matter The

[9] Friedrich Hayak ` **Road to Serfdom"**, routledge & Kegan Paul, London, 1976

issue then is: Are the ER's really replenishable/reproducible? Or, can they be? Can we really replenish to bring back to their **original form** or the pre-damaged levels? What about the costs of effluent treatment and how to deal with them? What about time lags? From this framework, the two following major issues follow that are bothering the policy-makers. They are:

a. Environment is becoming a major limiting factor/imposing severe constraints on development. The very objective of public policy is at stake. In this regard, the public participation through agitational means is raising. Policy-makers are not able to cope with this new trend.

b. Costs of environmental protection/preservation etc. are pushing up the over-all costs in the economy and thereby, adversely affecting the competitive strength of the economy. Environmental legislation is posing severe problems on growth.

In this regard, the following propositions may be considered:

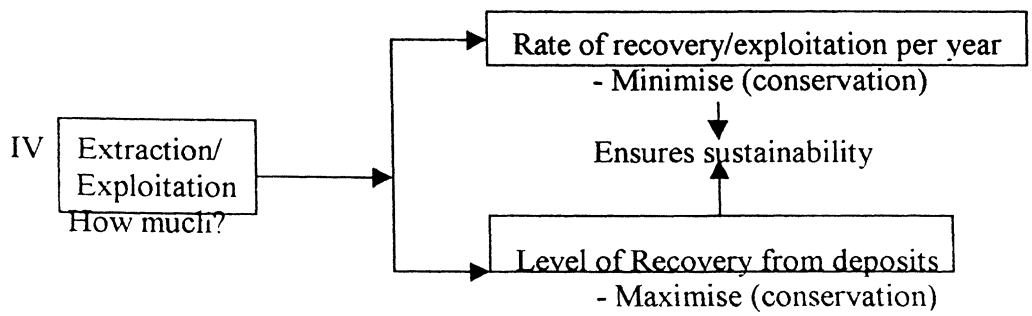
i. All human actions whether they are economic, engineering, social etc., are directed towards **altering and using** the environmental (natural) resources to satisfy all the human needs/wants.

ii. All human actions whatever they are, have definite and certain impacts on environmental base; and

iii. All the policies,. in effect, are geared either directly or indirectly towards facilitating, promoting and using the natural resources for the material benefit of man.

This being the case, the whole concern is on the **limits of growth** and on the width of the spectrum between which the policies can operate effectively without causing much damage either to environment or to the posterity by integrating all the parameters on hand viz., environment, development, conservation and exploration to arrive at a holistic approach. This holistic approach thus framed is claimed to integrate both demand-side and supply-side management approaches to formulate the public policies that ensure sustainability.

In the same vein, one more choice is there, as below:



Note: Given the quantum of known resource-base and when exploration reaches its assymptotic limits, the only way to achieve a sustainable resource base is to minimise the Rate of annual recovery and maximise the level of recoveries from the existing deposits (See, Diagram-2, p 386 in Naganna, 2000). But it is difficult to implement this policy strategy.

The list of social/public choices in resource-base management as given here is by no means exhaustive. We could identify only a few issues of wider public concern depending on our interests and value judgements. Choices are to be made keeping in view of the resource base and its sustainability because the policies, in effect, are guided by and adhere to the extent of natural resource endowments. Mere empty slogans and target fixing do not as also should not make public policies. In this context, there could be several social issues (choices) of wider public interest/concern such as the tightening of belts, reducing population pressure on resource-base, social demarketing, controlling and regulating wasteful consumption, checking consumerism and the list goes on. However, the social/public choices as presented above, can be determined with reference to the population, the poverty levels, geographical area, resource base, the current state of environment, and of sort.

It has been observed that the world has used more minerals---including oil---in the past 30 years than in all previous times (See also, Table 3). Our case study on coal resources of Andhrapradesh reveal that the sum of coal out during the latest ten years is more than the total sum of the previous 100 years output. This is the rate at which depletion is taking place. This may put us in the awesome materials crisis (shortages). There are no '**instant**' reserves and no '**instant**' cheap extraction facilities. It takes long time and large investments to discover resources and then convert them into reserves and then process them into raw materials. This spectrum is long and complex associated with several risks and uncertainties enroute. This has to be specially kept in mind while formulating public policies.

At present, the core of public policy making centres around achieving growth and development in society and thereby, increase the consumption-driven living standards/social welfare. It is argued in this paper that this basic paradigm needs to be shifted or broadened to encompass the supply-side also. In a sense, the present scheme of things or the policy-design is lopsided because it does not provide much space for resource base analysis. For instance, the concept of economic development, laden with so many theories and models, does not consider the critical issues of resource-base and its sustainability, exploration, exploitation and conservation in any significant manner. Most of the text book models never mention such critical issues of wider concern.

Appendix-1

Table-1
Concentration in Production of Eleven Metallic Minerals in 1973

Material	Major producers other than United States	Concentration of named countries' share of world production (%)
Bauxite	Australia, Jamaica, Surinam, Guyana, guinea, Dominican Republic	68
Chromium	South Africa, Turkey, Rhodesia, Philippines	46
Copper	Canada, Chile, Zambia, Zaire, Australia, Peru, Philippines, South Africa	50
Iron Ore	Australia, Canada, Brazil, India, Sweden, Liberia, Venezuela, Chile	36
Lead	Australia, Canada, Mexico, Peru, Yugoslavia, Morocco, Sweden	41
Manganese	South Africa, Brazil, Gabon, India	42
Mercury	Spain, Italy, Mexico, Yugoslavia, Canada	56
Nickel	Canada, New Caledonia, Australia	59
Tin	Malaysia, Bolivia, Thailand, Indonesia, Australia, Zaire, Nigeria	74
Tungsten	Thailand, Bolivia, South Korea, Canada, Australia, Portugal	28
Zinc	Canada, Australia, Peru, Mexico, Japan, West Germany, Sweden	52

Source : David Novick, "A World of Scarcities – critical issues in Public Policy"

Table-2
Life Indices of Some Important Minerals in India

Sl. No.	Mineral/Ore/ Metal	Recoverable reserves as on 1.1.1985 (m.tonnes)*	Depletion during 1985-97 (m.tonnes)	Recoverable reserves as on 1.1.1997 (m.tonnes)	Projected production during 1996-97 (m.tonnes)	Balance life at 1996-97 level of production (Years)++
	1	2	3	4	5	6
1	Crude oil + 1.1.91	993.00	230.00 (1991-97)	763.00	50.00	15.26
2	Natural gas $ (B.Cu.m) As on 1.4.90	858.00	161.00 (1990-97)	697.00	30.00	23.00
3	Coal (as on 1.1.91) i. Coking	8507.00	201.00 (1991-97)	8306.00	39.00	213.00
	ii.Non-Coking	60346.00	1397.00 (1991-97)	58949.00	269.00	219.00
4	Bauxite	2333.00	80.00	2253.00	8.00	281.00
5	Copper metal #(as on 31.3.88)	3.95	0.431	3.52	0.055	64.00
6	Lead metal # (as on 1.1.89)	1.93	0.56	1.36	0.096	14.00
7	Zinc metal # (as on 1.1.89)	7.00	1.10	5.89	0.154	38.00
8	Gold (as on 1.1.88)	1030000 kg (Extractable)	16727.00	86273.00	1850.00	46.00
9	Iron ore	10440.00	686.00	9754.00	72.00	135.00
10	Chromate Ore	139.00	15.00	124.00	2.40	51.00
11	Magnesite	222.00	6.70	215.00	0.73	294.00
12	Manganese Ore	83.17	17.65	65.52	1.80	36.00
13	Limestone	69355.00	876.00	68477.00	101.00	Adequate Reserves
14	Rock Phosphate High Grade	14.78	8.79	5.99	0.72	8.00
15	Sillimanitei)Massive	0.50	0.35	54.25	0.017	Beach Sand+1000
	ii. Beach sand	54.10				
16	Kyanite	1.55	0.51	1.04	0.056	18.00
17	Dolomite (useable grade)	4608.00	32.00	4576.00	3.20	Adequate Reserves

+ - Background note of Eighth Plan (1992-97)
++ - Life of mineral deposits would change on revision of recoverable reserves.
* - Based on Eighth Plan Working Group report on Mineral Exploration, Aug. 1989
$ - figures are tentative as natural gas reserves depend upon reservoir characteristics
# - Producing & developing mines

Source : **Eighth Five Year Plan**, p. 35, Planning Commission, GOI.

Table 3
Value of World Mineral Production (in $ billion)

	1950	1960	1970	1980
Global GNP	**3932.00**	**5805.00**	**9363.00**	**13108.00**
Energy fuels				
Petroleum and gas	24.30	37.00	50.30	704.70
Coal	80.60	86.40	104.60	169.90
Others	6.20	13.00	28.80	104.90
Total	111.10	136.40	191.60	979.50
In % of GNP	**2.82**	**2.35**	**2.05**	**7.47**
Metallic resources				
Iron and iron alloys	20.80	33.50	48.40	47.60
Precious metals	4.40	5.40	7.60	39.10
Base metals	12.20	25.90	54.70	68.80
Others	0.40	0.60	1.80	1.30
Total	37.80	65.40	112.50	156.80
In % of GNP	**0.96**	**1.13**	**1.20**	**1.20**
Non-metallic resources				
Construction materials	-	39.90	69.30	100 60
Fertilisers	2.90	6.00	8.50	16 50
Diamonds	-	2.00	4.10	9 10
Chemical resources	6.30	12.10	18.00	32 40
Total	40.70	60.00	99.90	158.60
In % of GNP	**1.04**	**1.03**	**1.07**	**1.21**
Total mineral resources	189.60	261.80	404.00	1295 00
In % of GNP	**4.82**	**4.51**	**4.32**	**9.88**

Source: Werner R Gocht, Half Zantop & Roderick Eggert, **"International Mineral Economics"**, p 6

Table 4
Major Fuel Consumers in the Manufacturing Sector : 1973-74 & 1989-90
Fuels Cons./Val. Of Output (%)

Industry	1973-74	1989-90
Iron & steel	10.6	11.2
Cement, lime and plaster	25.1	33.6
Aluminum	14.2	22.4
Pulp, paper and paper board	10.1	17.6
Foundries for casting and forging of iron and steel	5.0	5.1
Ferro alloys	21.6	36.7
Glass and glass products	16.6	22.0
Structural clay products	15.1	21.0
Basic organic and inorganic chemicals	9.8	4.6
China-ware and porcelain-ware	15.3	20.1
Zinc	3.5	13.3
Copper	3.1	7.6
Ice	26.3	8.6
Synthetic resins, fibres, plastic materials, etc.	6.1	4.5
Fertilisers and pesticides	8.6	8.0
Cotton spinning and weaving	4.1	6.7
Starch	5.0	2.0
Common salt	5.2	8.2
Slaughtering, preparation of meat	3.2	4.7
Dyeing and bleaching of woolen textiles	9.7	29.9
Printing, dyeing and bleaching of silk textiles	4.6	13.0
Manufacturing		
Factories (Numbers)	60889	1,03,373
Fuels consumed (Rs. Lakhs)	73667	13,36,025
Fuels Cons./Val. Of output(%)	4.0	6.4

Source: CMIE, June 1994

Table -4a

Overall Expenditure of Central govt.

	1996-97	1995-96	increase
Receipts	216386	188241	28145
Expenditure	283119	248485	34634
Fiscal Deficit	66733	60244	

[on a Gross basis including States share of taxes]
(Rs. in crores)

(Rs. in crores)

Year	Plan	Non-Plan	Total
92-93	36660	85958	122618
93-94	43662	98191	141853
94-95	47378	113361	160739
95-96	46374	131901	178275
96-97	53535	147473	201008

Note: The objective of these table is to get a feel of the problem on hand . To this, the expenditures of state & local self - govts are be added to get overall picture of public spending besides private consumption expenditure. These data indicate the extent of pressure /stress imposed on the resource -base.

TABLE 4B

Receipts and Expenditure of the Central Government

	1990-91	1995-96	1996-97	1997-98	1998-99*	1999-2000**
				(Rs crore)		
1. Revenue receipts (2+3)	54954	110130	126279	133901	150532	182840
2. Tax Revenue (Net of States share)	42978	81939	93701	95672	105135	132365
3. Non-Tax Revenue	11976	28191	32578	38229	45397	50475
4. Revenue Expenditure of which	73516	139861	158933	180350	216162	236987
(a) Interest Payments	21498	50045	59478	65637	78559	88000
(b) Major Subsidies	9581	12430	14041	18238	21030	22440
(c) Defence Expenditure	10874	18841	20997	26174	29774	33464
5. Revenue deficit (1-4)	18562	29731	32654	46449	65630	54147
6. Capital Receipts of which	31971	48348	50872	82435	104509	101042
(a) Recovery of loans	5712	6505	7540	8318	10146	11087
(b) Other receipts (mainly PSU disinvestment)	–	1397	455	912	5871	10000
(c) Borrowings and other liabilities	26259	40446	42877	73205	88492	79955
7. Capital expenditure	24756	28424	31403	35986	38879	46895
8. Total expenditure of which	98272	168285	190336	216336	255041	283682
(a) Plan expenditure	28365	46374	53534	59077	66887	77000
(b) Non-plan expenditure	69907	121911	136802	157259	188154	206882
9. Fiscal Deficit (1+6(a) + 6(b) - 8)	37306	50253	56062	73205	88492	79955
10. Primary Deficit	16108	208	-3416	7568	9933	-6045
10.1 Primary deficit Consumption	6358	-147	-2364	8816	21023	443
10.2 Primary deficit Investment	9750	355	-1052	-1248	-11090	[illegible]
			(As per cent of GDP)			
1. Revenue receipts (2+3)	10.3	9.3	9.3	8.8	8.5	9.5
2. Tax Revenue (Net of States share)	8.0	6.9	6.9	6.3	6.0	[illegible]
3. Non-Tax Revenue	2.2	2.4	2.4	2.5	2.6	[illegible]
4. Revenue Expenditure of which	13.7	11.8	11.7	11.9	12.3	[illegible]
(a) Interest payments	4.0	4.2	4.4	4.3	4.5	[illegible]
(b) Major Subsidies	1.8	1.1	1.0	1.2	[illegible]	[illegible]
(c) Defence expenditure	2.0	1.6	1.5	1.7	[illegible]	
5. Revenue deficit	3.5	2.5	2.4	3.1	3.7	[illegible]
6. Capital Receipts of which	6.0	4.1	3.7	5.4	5.9	
(a) Recovery of loans	1.1	0.6	0.6	0.5	0.6	
(b) Other receipts (mainly PSU disinvestment)	0.0	0.1	0.0	0.1	0.3	[illegible]
(c) Borrowings and other liabilities	4.9	3.4	3.1	4.8	5.0	[illegible]
7. Capital expenditure	4.6	2.4	2.3	2.4	2.2	[illegible]
8. Total expenditure of which	18.4	14.2	14.0	14.3	14.5	[illegible]
(a) Plan expenditure	5.3	3.9	3.9	3.9	[illegible]	
(b) Non-plan expenditure	13.1	10.3	10.0	10.4	[illegible]	
9. Fiscal Deficit	7.0	4.3	4.1	4.8	[illegible]	
10. Primary Deficit	3.0	0.0	-0.3	0.5	[illegible]	
10.1 Primary deficit Consumption	1.2	-0.0	-0.2	0.6	[illegible]	
10.2 Primary deficit Investment	1.8	0.0	0.1	[illegible]		
Memorandum items				(Rs crore)		
(a) Interest Receipts	8730	18419	22106	[illegible]	[illegible]	
(b) Dividend and Profit	564	1749	[illegible]	[illegible]		
(c) Non-Plan Revenue Expenditure	60896	110840	127298	145176	[illegible]	

* *Provisional and unaudited as repoted by Controller General of Accounts, Department of Expenditure, [illegible]*

Note: 1. The figures may not add up to the total because of rounding approximations.
2. Primary deficit consumption = Revenue Deficit-interest payments+interest receipts+dividend & profits.
3. Primary deficit investment = Capital expenditure interest receipts Dividend & profit-recovery of loans [illegible]
4. Figures are exclusive of the transfer of state's share of net Small Savings Collections.

Appendix – 2

Production and Environment : A suggestion

Till recently, the environment and production were considered as independent, separate and distinct entities while in fact, they are not so. This is the gravest mistake unparalleled with any other one in the history of human thought, knowledge and skills. Consequent upon this dichotomy, the production planning and environmental protection planning were developed as two distinctly different processes. In fact, they are not so. The need of the day is to integrate and combine these two into one with in-built mechanisms to minimise the material-intensities (or the input-output ratios) as also to treat the process wastes as part of the production processes. Similarly, "recycling and recovery" needs to be made as an integral part of the production processes. The need, therefore, is to develop an integrated technology in which the environmental protection is built-in. then, the costing and pricing will be adjusted and adopted accordingly and thereby, the "costing and pricing" of products will take care of the environmental protection costs through built-in mechanisms. In such a case, the conflict between environmental protection and economic competitiveness becomes, in fact, a false dichotomy. In the same vein, the complex problems of environmental policy making and implementation will almost tend to wither away.

So far, environment is treated as an exogenous element to the manufacturing system. Instead, it should be made endogenous in the interests of environmental stability and quality of life.

It takes time. Because, the whole technology needs to be reoriented. Till such time, the policies have to encourage treatment, and "recycling and recovery" of wastes/residuals.

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* Michael Porter, "American Green Strategy", **Scientific American**, April 1991, p. 168.

Development = Production = COMMODITIFICATION of natural resources ∴ Conservation.

PART – II

Resources Analysis

NATURAL RESOURCES : A Conceptual Analysis

Rivers, forests, climate, lands, minerals and such other sources constitute the natural endowments which together add up to a nation's natural wealth. Together, they constitute nature's bounty. These resources are not to be lavishly consumed away recklessly and exhausted by any one generation. Every generation owes a duty to succeeding generations to develop and conserve the natural resources of the nation in the best possible way.[1] It is in the interest of mankind. Because, earth takes several millions of years to get a mineral/ore formed in its crust through various lengthy and complex geo-chemical processes. Such a valuable stuff has to be used with utmost caution by the appropriate application of technology, economics and politics.

Role of Minerals (including energy minerals); The role and importance of minerals in the development process NEEDS no emphasis. The whole economic/production structure, in the long run, depends upon the quality, structure and the geographical distribution of the subsoil resources endowment in a country. Hicks-Ohlin theorem is a case in point. The development path followed by different countries indicates that the former is guided by and adheres to the changes in the later. Such is its role. This sector provides the basic foundation upon which the modern industrial society is built. Some of the popular quotations EXPLAIN the case in point, such as:

- **Mankind's progress** is measured in minerals
- "Modern man is almost **wholly dependent** on the mineral kingdom for his existence" (But, this dependence is not realised)
- "Minerals can be regarded as man's principal physical material in the development of the **industrial civilisation**"
- Minerals are the **mainsprings** of material civilisation.

Thus, the minerals are considered as the mainspring of material civilisation. The extent of their availability in right quantity and quality and in right location ATTRACTS the direct foreign and domestic investments in the context of liberalisation policies now accepted by almost all the countries. Why some countries are able to attract large foreign investment while others not, can be explained by the endowed resource-base of the respective countries. Resource-base directs generally the path of development to be followed by a country. There could be some exceptions like Japan.

The role and importance of minerals including the mineral energy resources can be OBSERVED by the fact that several WARS were fought both in the past and in recent years essentially for the SAKE of CONTROL over minerals. The recent gulf war would substantiate the case in point. In point of this fact, it can be said that the economic progress of a country is determined by the extent of resource endowment within its own

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[1] Charles R. Van Hise, **"The conservation of Natural Resources in the United States**; the Mac Millan Co., 1910. Naganna (2000), op.cit. Richard M Auty, **"Sustaining Development in Mineral Economies"**, Routledge, London, 1993. David Novick, **"A World of Scarcities : Critical Issues in Public Policy"** Associated Business Programmes, London, 1976

geographical boundaries or the extent of its access through agreements, pacts, deals etc., and control through political means over resources endowed in other countries. In either case, resource base determines development.[2] However, some studies reveal that excessive dependence (as a % in GDP) on mining sector will lead to **a state of resource-curse** by discouraging diversification in the economic system.[3]

Role of Mineral Fuels: They have a very special role to play in the material progress of mankind. They include all kinds of coals, oil, natural gas and nuclear minerals. They are also called mineral energy resources or fuel resources. Earth took several millions of years in FORMING them after undergoing various kinds of geo-chemical processes/reactions as also massive disturbances deep below the earth's crust.

The minerals are essentially non-renewable and also non-replenishable. This is to say that a ton taken out from the earth's crust is gone forever. It can not be replenished. Another important characteristic feature is that they are all mostly subsoil resources and hence, are not normally VISIBLE to the human eye. They are the hidden treasures endowed at large depths below the earth's crust.

It should be specially noted that it is the mineral fuels that CONVERT (or processes) the rest of the minerals from their RAW FORM into USABLE FORMS, besides producing energy, a vital input for all socioeconomic and industrial activity. For instance, it is coal that converts the iron ore into steel or any other metal. Similarly, glass, cement and so on. Similarly, oil for transport needs no mention. Transport carries development. Thus, the "conversion" as said above, is an essential precondition for industry or for development at large. So to say, the **fuel resources convert the other minerals into raw materials** which will be later transformed into various products by the manufacturing systems.

From this it is clear that the mineral fuels have a decisive role to play in the process, structure, level and rate of economic development. This can be substantiated by the composition of fuel and non-fuel resources endowment in different countries and its relation with the corresponding patterns of development.

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[2] James F McDivitt and WG Jeffary, "Minerals and the Developing Economies" in **"Economics of the Mineral Industries"** (3rd ed.) Ed. By William A Vogely and Hubert E Risser, (American Institute of Mining, Metallurgical & Petroleum Engineers. Inc., Newyork. 1976). See also, S Sideri and S Johns (Ed.). **"Mining for Development in the Third World"**, Pergamon Press. 1980.

[3] Richard M Auty. op.cit.

Minerals and Public Policy:[4]

Minerals being the nature's gift/bounty belong to everyone in a sovereign state. Ownership is a critical issue in this sector. Everyone has an equal right over and an equal access to the natural resources endowed/embedded in the geographical boundaries of a country. The extent of publicness is enormously large and inherent to this extractive sector. This is its distinguishing feature. They are in fact the common property of the whole citizenry in a sovereign nation. This is one aspect. The other one is that they are the basic foundation on which the whole structure of the economy is built. Both these two aspects together bring out the inevitable interface between the minerals and the public policy.

Most of the public policies particularly pertaining to the industry and other related economic policies have either directly or indirectly and in some form or the other a significant bearing on mineral resources. As a matter of fact, they are the recipients of the impacts/incidence of the outcomes of the public policies. As said earlier, the public policies primarily centre around the endowed resource-base because it sets the broad boundaries within which the policy-making can operate. To substantiate the case in point, the content and direction of public policies take one form under conditions of scarcity while they will be different under conditions of plenty. Therefore, the conditions of scarcity or plenty will decide the nature, content, scope and significance of public policy making in a country. The India's Eighth Five Year Plan document clearly demonstrates this inter-connection.

In this context, the Eighth Plan (p.35) furnishes a broad profile of the country's known mineral resource-base along with its durability. (See, Table-2 in Part-I of this paper). By any standards, this resource-base is far from adequate to sustain a billion population whose aspirations and life expectancy have increased substantially in recent years. keeping in view of this fact, the eighth plan warns that the foreign trade in non-ferrous minerals needs to be cautious. In the same vein, it advocates a **policy initiative** focussing on the long term sustainability and the efficient use of resources across all the sectors. The fact of the matter is conservation at all levels. In a sense, it justifies the need for and gives credence to the present study.

The Meaning of Natural Resources: There are various definitions of a natural resource in literature on mineral economics. It has a vast variety of meanings with no fixed connotation. They are:

(a) "A resource is something that is useful and valuable in the condition in which we find it. In its raw or unmodified state it may be an input into the process of producing something of value, or it may enter consumption directly and thus be valued as an amenity"

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[4]VE McKelvey, "Mineral Resource Estimates and public Policy". **American Scientist**, Vol.60, p.32, Jan.-Feb. 1972. Naganna (2000), Op.cit. See also, Rex Bosson and Bension Varon, **"The Mining Industry and the Developing countries"**, Oxford University Press, 1977.

(b) ".... **All the living and non-living endowment of the earth....**"
The major classes of natural resources[5] are:

(i) Agricultural land
(ii) Forest land and its multiple products and services
(iii) Natural land areas preserved for aesthetic, recreational, or scientific purposes.
(iv) The fresh and salt water fisheries
(v) Mineral Resources that include mineral fuels and non-fuels
(vi) The Renewable non-mineral energy sources of solar, tidal, wind and geothermal systems
(vii) Water Resources and climate/air
(viii) The **waste-assimilative capacities** of all parts of the environment.

(c) The **most commonly used definition** on mineral resources is:
"A concentration of naturally occurring solid, liquid, or gaseous materials in or on the earth's crust in such form that economic extraction of a commodity is currently or potentially feasible".

(d) There is yet another definition of mineral resources:
"The term (mineral resources) will be taken to include all NON-living, naturally occurring substances that are useful to man whether they are inorganic or organic. Thus, all natural crystalline solids, fossil fuels such as petroleum and natural gas, as well as the waters of the earth and gases of the atmosphere fall under this definition of mineral resources".

(e) The geologists define a mineral as "a naturally occurring substance with a definite chemical composition or one which varies within specific limits, usually with a crystalling structure, and possessing a set of distinctive physical properties".

The legal definition of a mineral varies in accordance with the mining laws of different countries. However, the "mineral" is defined to include "materials of mineral origin, as distinct from materials of organic origin".

In these definitions, the HUMAN ELEMENT that plays a vital role in developing and utilising natural resources, is IGNORED. These definitions look at natural resources as a static stock; an INVENTORY of a FINITE amount of tangible substances while the resources is in fact dynamic in nature. Thus, the definitions from (a) to (d) do not furnish the real meaning and content of the word "resources". They create more confusion than clarity. Since the above definitions present a narrow point of view, they are causing widespread misconceptions. .

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[5] The natural resources are also classified into: (a) **Renewable,** and (b)**Non-renewable**/non-replenishable. Yet, another categorisation is between: (a) Scarce; and (b) Abundant. It may be noted that the resource analysis varies from one category to the other. So also, the exploration and conservational policies/measures

Taking into account of the deficiencies in the above definitions, yet another one is put forward. This definition considers the resources as:

(f) - *"... living phenomena, expanding and contracting in response to human effort and behaviour..... To a large degree, they are man's own creation. Man's own wisdom is his premier resource.... the key resource that unlocks the universe....."*

According to this definition, the concept of resources gets transformed from its earlier static viewpoint to a dynamic one. It is man's wisdom/knowledge that identifies, assesses and attaches the "meaning, use/utility and value" to resources. A resource gets its cognizance and value only by man. Otherwise, it does not exist as a resource but only as a useless neutral stuff. By this definition, the concept of resources is better summarised as:

⇒ "RESOURCES ARE NOT .... THEY BECOME"

This statement is self-explanatory and follows from the above definition (f)

(g) The Indian Bureau of Mines (IBM) considers a mineral in a very broad manner. It considers a mineral as the one that grows in a mine. It also states that a mineral can be every substance forming part of the crust of the earth other than or possibly even including the layer which sustains vegetable life. In its legal sense, the word 'mineral' has been held to include, **prima-facie** every substance which can be got from underneath the surface whether by underground workings or by open quarrying. In a general sense, minerals are those part of the earth which are capable of being got from underneath the surface for purpose of profit.

Mines themselves have been in law understood to be excavations from the earth from which a useful product is extracted by reason of these being a deposit of useful material.

(h) In the context of mineral economics, the term '**mineral resources**' is commonly used to denote all solid, liquid, or gaseous geologic materials exploitable for use and profit. In practice, the mineral resources are generally classified by their use into building materials, industrial minerals, metallic minerals and energy minerals, all of which are needed for construction, agriculture, industry and transport.

THREE PRE-REQUISITES FOR A RESOURCE:

There are **three pre-requisites** before the process of creating resources can take place. They are:

(1) There must exist some substances, naturally-occurring "neutral stuff"
(2) There must be human demand for these substances, and

(3) The TECHNOLOGY to process these substances and to use them to benefit mankind must EXIST.

(Neutrality refers to utility, salability and value)

When these three conditions are satisfied, then the process of CONVERSION of NEUTRAL stuff to USEFUL resources takes place.

[Neutral Stuff] ⟶ **[Resources]**

Since the conversion process is mostly techno-economic in nature, it takes place through the developments in technology and markets. Experience shows that the conversion process is limited by the extent of markets. The extent of markets is one of the major determinants of the conversion of neutral stuff into resources. It may specially be noted that the two primary elements in a resource are:

SALABILITY, and
UTILITY

These two together make or unmake a resource. Absence of any one of the two will lead to the age-old water-diamond controversy. Another important property of a resource is that it has **"scarcity value".**

The process is not necessarily a one-way conversion. When there are changes in the existing conditions (Eg: technology has developed good substitutes; there was a change in taste or NEED), then resources may CONVERT back to neutral stuff and will cease to be presently useful for human beings.

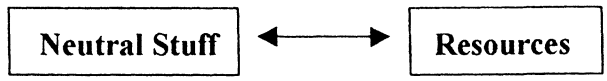
[Resources] ⟶ **[Neutral Stuff]**

There are several cases to demonstrate these reversible processes. For instance. The existence of uranium compounds has been known since 1789 and the element itself has been isolated by 1842. Yet, for many years there was no human need for it. It was just a neutral stuff. When the demand finally arose (use of uranium for nuclear weapons), technology for processing developed; and the neutral stuff was converted into a resource. Hopefully, the future use of this specific resource will be of a constructive nature only as a fuel in industry, in agriculture, in medicine etc. Or, at times, new resources may be created out of neutral stuff through technology such as pellets from iron ore. Technology may also convert non-salable lower grades of ores (neutral stuff) into salable grades (resources) through benefaction process. The example for the reversible process is as under:

> ***For many years the major source of supply of cryolite (an important ingredient in the production of aluminum metal) has been a commercial deposit located in Greenland. The difficult accessibility to and mining of this deposit through out the year forced the aluminum companies to develop synthetic material made of sodium, fluorine, and aluminum. Most of the natural cryolite RETURNED BACK to the state of being neutral stuff, due to development of new technology as a result of human demand.***

Similarly, there are a large number of legal and other restrictions to the use of high-sulfur coals in the USA. It needs costly treatment for the removal of sulfur content in the coal. Without this treatment, high-sulfur coal may, in part, REVERT BACK to neutral stuff.

Thus technology, markets, present and potential substitutes, prices, tastes, needs etc., have a significant role to play in converting the neutral stuff into resources and vice versa. It can be represented as:



Since the above factors constantly change from time to time, the conversion process acts in both the ways depending upon the situation.

The broad dynamic view of natural resources has a lot of merit. However, such a broad concept of evolving and ever-changing phenomena is very difficult to quantity at any point in time. Yet, we need quantification in planning the current and future policies and strategies.

A Digression on Exploration and Public Policy:

Since minerals are hidden and unknown, they need to be discovered, evaluated, assessed and bring them to fore of the public for their exploitation and utilization. Searching for and finding out the hidden minerals is said to be the concern of exploration It is the systematic search for mineral resources by the mining companies or government agencies on the basis of direct and indirect geological evidence/information, and with the help of empirical and genetic models of mineral occurrence and formation. As against this, there is another similar activity called the '**prospecting**' which is at times used as a synonym. It is considered to be the search for mineral resources by individuals on the basis of direct observation of surface data such as the rock formation, vegitation, mineral assemblages, exposures/outcrops and so on. (See, Naganna, 2000). After a mineral is thus suspected to be present below the surface, then other steps follow, such as the evaluation and assessment, getting the mining lease and feasibility studies to open up the mining projects. Thus, before the delivery of minerals, the mining projects begin with the search for a mineral target that meets a set of economic, geologic and technical requirements

There are broadly two lessons to learn from this brief account. The first is that the journey from resources to reserves and to the actual delivery of minerals is long and tedious. The second is that there are several stages that a mining project has to undergo before it gives us the minerals and each is stage is ridden by a variety of risks and uncertainties. Therefore, the minerals do not come just by asking.

Most mineral deposits located at or near the earth's surface have probably been discovered. The trend towards exploration of mineral deposits that are less exposed or not exposed on the surface has led to the increased application of a variety of new exploration tools which allow both a deeper penetration into the subsurface and better geophysical signals. The exploration tools include: Remote Sensing, Aerial Photography, Geophysical Exploration, Magnetic Surveys, Electric Surveys, Electromagnetic Surveys, Radiometric Surveys, Gravimetric Surveys, Seismic Surveys, Airbore and Ground Geophysical Surveys, Geochemical Surveys etc. The factors like the large amounts of costs/expenditures involved, the technical personnel required, the large areas needed, and the risk and uncertainties involved etc., **limit** the application of the sophisticated exploration methods to only the big companies and to the governments. Further, the choice/application of the exploration tools as listed above to find and evaluate the minerals are mainly **resource-specific.**

Exploration being what it is, the role of government in this crucial and vital enterprise is imminent particularly where the private enterprise is not well developed and well established on a large scale which is willing to bear the 'risk and uncertainty' in exploration. Exploration is a basic foundation upon which the rest of the economic sectors are built and dependent. Obviously, this is in the realm of public policy (See, Naganna, 2000) because the profit motive of private enterprise may not permit it to enter into this highly risk-prone area. So far, no adequate space is given to this vital issue of exploration and resource-base in public policy analysis. Hence, this attempt. We have to provide not only space for these vital aspects, but **positioning them** in the scheme of things is equally or perhaps even more important Later task is left unattended.

CLASSIFICATION OF DEPOSITS : (OR THE OUTCOMES OF EXPLORATION)[6]

It may be noted that the output or the outcomes of exploration programs is the knowledge/information regarding the presence or absence of mineral deposits and their quality, quantity, geological properties and mineability It is primarily a capital-intensive and a high-risk activity. It may yield or it may not yield any bit of meaningful information. That is why, the "failures" are equally important in this risk-prone activity. These issues apart, it is necessary to analyse the outcomes of exploration such that they become useful in policy analysis relating to exploitation, conservation, technology, pricing, environment protection and so on In the ultimate analysis, the exploration tries

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[6] RG Burn. **"Exploration Risk"**. See also. Brian W Mackenzie. **"Looking for the Improbable Needle in A Haystack : The Economics of Base Metal Exploration in Canada"**. both in FJ Anderson (Ed.). **"Selected Readings in Mineral Economics"**. Pergamon Press. 1987

to create a new hitherto not known resource-base upon which the industrial edifice is to be built. Thus, "resources" become central to exploration. In what follows, is a brief analysis of "resources" in its varied meanings, content and categories.

Resource nomenclature, as used by people in the mining industry and energy industries, has been inconsistent and confusing. As a result, we find ourselves with a number of different resource estimates. The major sources of confusion are with the terms RESERVES AND RESOURCES as also how to distinguish between these two groups. This distinction is very important for all those engaged in the utilisation of minerals and fuels, and for the regulatory and planning authorities. The deposits are classified generally according to THREE aspects, viz.,

- **geologic occurrence,**
- **economic aspects, and**
- **technological feasibility**

On the basis of these three parameters, the subsoil (mineral) resources are categorised under three broad groups. From this, three terms are used to describe the total mineral resources as:

- **Reserves.**
- **Resources, and**
- **Resources base**

The criteria for classifying the mineral deposits into the above three categories are given below in a tabular form.

Table 1 : Resources Classification by Selected Traits

Sl.No.	Terms	Occurrence	Economic	Technologic
1	Reserves	Known	Present cost level	Currently feasible
2	Resources	Known and Unknown	Any cost level specified	Currently feasible and feasibility indicated in future
3	Resource-base	Known and Unknown	Irrelevant	Feasible and infeasible

RESERVES: Reserves include minerals in deposits fulfilling all the three conditions, viz.,

(a) they are geologically known (quantity and grade),
(b) their production is economically feasible at the present, and
(c) the technology for their extraction, processing and use is currently available.

Most operating mines, quarries and hydrocarbon fields are included in this category. Reserves as seen satisfying all the above three characteristic features are readily available for immediate exploitation. In other words, they have markets, technology, utility and salability, as also the geotechnical information is available in sufficient detail.

RESOURCES: It denotes potential reserves. At the present, resources DO NOT meet one or more of the criteria for reserves, either because:

- their geological occurrence is not fully known,
- their estimated production costs are HIGH in relation to the existing market prices, or
- their technology has NOT yet been fully developed, even though further development in the future is likely to take place.

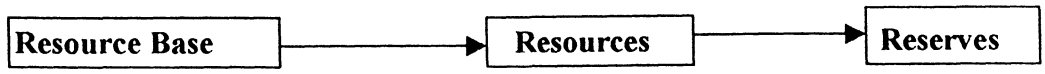
The vast deposits of oil SHALE in Colarodo, Utah, and Wyoming is a good example to demonstrate this resources category.

Although mostly known, their economic feasibility is NOT yet assured, nor have several technical and environment aspects (such as recovery rate, disposal of the spent shale, and water use) been satisfactorily solved. It is expected, however, that these problems will be solved in the near future and the economic PROSPECTS for a commercial oil shale industry will improve. A similar example is the production of alumina from clays, instead of bauxite whose prices are going up rapidly. Another example is lignite. At one time, it was considered to be a resource with no economic value. Now, it has been converted into a reserve by technological developments. Similarly, peat is in the process of getting a reserve status due to the growing acceptance of the concept of eco-agriculture.

Resources thus considered are the potential reserves for exploitation at a later date. They are the reserves of the future because they are convertible. Technology, relative prices of minerals, environment legislation, non-availability of substitutes etc. are some of the deciding factors for the commercial exploitation of resources at a future date. Resources position or the resource-base is essentially a continuously changing process with changes in technology, markets etc. So to say, today's weakness is tomorrow's strength and vice versa. This the history of minerals unfolds.

RESOURCE-BASE: It includes all minerals and fuels embedded below the earth's crust at varying depths, regardless of concentration or the % ore content In this case, the economic aspects and the degree of technological progress are BOTH IRRELEVANT. HOWEVER, the resource-base category provides with the ESTIMATES of the ULTIMATE SUPPLY of minerals and fuels ON and IN the earth's crust at maximum conceivable depths both accessible and inaccessible at the present level of technology. This being the case, it imposes the asymptotic limits to growth or an upper bound beyond which the resource exploitation can not be pushed. Since it gives a broad quantitative dimension, the total conceivable resource endowment irrespective of technology and economic feasibility, it has a direct relevance to sustainable development or the ultimate carrying capacity. **The public policies dealing with the resource exploitation and economic development need to consider the broad implications of resource base and the likely constraints it imposes.**

The resource dynamics can be shown diagrammatically as a flow from:



It is very likely that the borderlines between any two categories are not very accurate as also the length of the transition period. In fact, the **`resource-base'** to **`reserve'** is a long tedious journey. Also, over time there will be movements across borderlines, from a lower category of resources to higher one, as well as movement downward, because of changes in our geological knowledge, economic environment, and level of technology. However, the above diagram depicts the path of conversion taken by the endowed resources to become workable reserves to supply the minerals.[7]

The three major points that are considered in the above classification are:

(a) Economic and technological feasibility, in addition to the geological knowledge of the mineral deposits.
(b) A distinction between reserves and potential resources (reserves) and
(c) The Resource Base to provide the ultimate scope of the minerals' availability now and in the future. (Sustainability)

The resource classification and accurate distinction among the various categories are of vital importance in resource appraisal and appraising future supplies which are necessary in policy and planning

- **The need to differentiate the "Known and Recoverable" from the "Undiscovered and the Uneconomic" REQUIRES that a resource classification system convey two prime elements:**

(a) the degree of certainty about the existence of materials; and
(b) the economic feasibility of RECOVERING them.

RESOURCES ANALYSIS: Just the meaning and categorisation of resources is not enough. Resources being what they are, require a more detailed analysis to make their role more effective in public policy analysis. In both resources and public policy analyses, the two common factors are

- The element of risk and uncertainty, and
- The element of future

HL Martin, JA McIntosh and J Zwartendyk "Monitoring Canada's Mine production" in FJ Anderson (Ed). "**Selected Readings in Mineral Economics**". Pergamon Press. 1987. Pp 21-38 In this paper, the flow from resources to reserves and from reserves to supply of metals is explained through the '**Monitoring Curves**" constructed for some metallic ores In the same vein, see also, Robert B Parson, "**Turning Ore into rock**" in the same book

Both deal with future and uncertainty. The time-element enters in a different way. Time brings a number of structural changes in technology of exploration, exploitation and utilisation of resources, markets, development of substitutes and so on. These changes will have impacts on resources position. Keeping these aspects in view, a more detailed analysis of resources is carried out.

The Mckelvey's Box: (See Fig.1 below)

In this box, a clear distinction is made between reserves and resources. The Reserve category includes all the geologically identified deposits that can be economically recovered. This category is subdivided into three groups, indicating a decreasing degree of certainty of deposits or structures known to exist:

PROVED; PROBABLE and POSSIBLE reserves.

All other deposits are included under the general term Resources, either because they are not yet discovered or because their recovery is not yet feasible. The Resource category is again divided into two subgroups:

- **Paramarginal; and**
- **Submarginal**

By definition, paramarginal are those resources that are recoverable at prices as much as 1.5 times the current price levels. Submarginal resources do not fit this condition. In this case, economics dominate over other considerations, broadly reflecting the geological parameters of depth and mineability.

Chart-3 : The McKelvey's Classification Method:

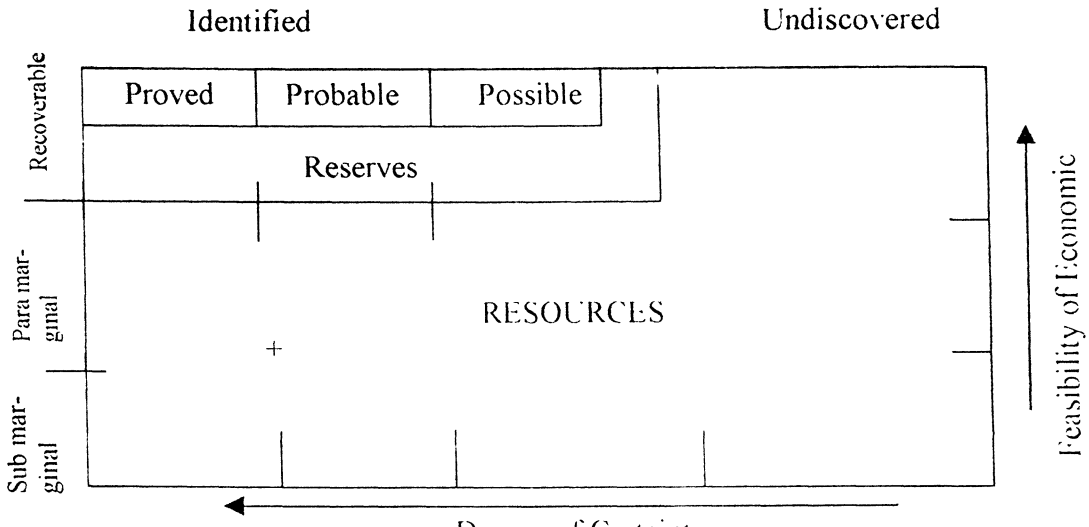


Fig 1 McKelvey's Classification Method

Source: McKelvey, "Mineral Resource Estimates and Public Policy" American Scientist, Vol 60, Jan -Feb 1972, p 35

Notes: (a) This gives a framework in a summary form or a clearly visible presentation to the outcomes of exploration. It gives the reserve-resource spectrum.
(b)The dynamics of Resource appraisal is presented in a schematic way.
(c)Useful for policy and planning. Serves as an instrument.

Chart-4 : The US Method of Resources Classification:

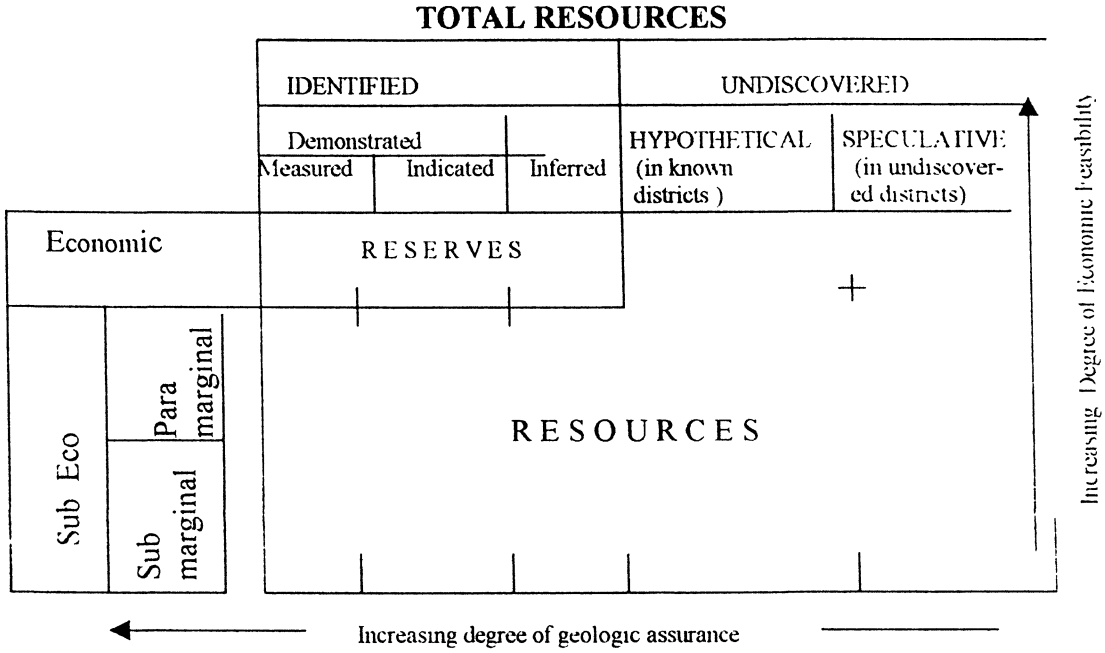


Fig.2 : The unified Department of Interior Classification Method (1976).

Source: Geological Survey Bulletin 1450-A, 1976. Of the resource/reserve terms, guidelines for classification of non-fuel mineral resources, and a two-part classification diagram.

Chart-5 : The Expanded McKelvey's Box:

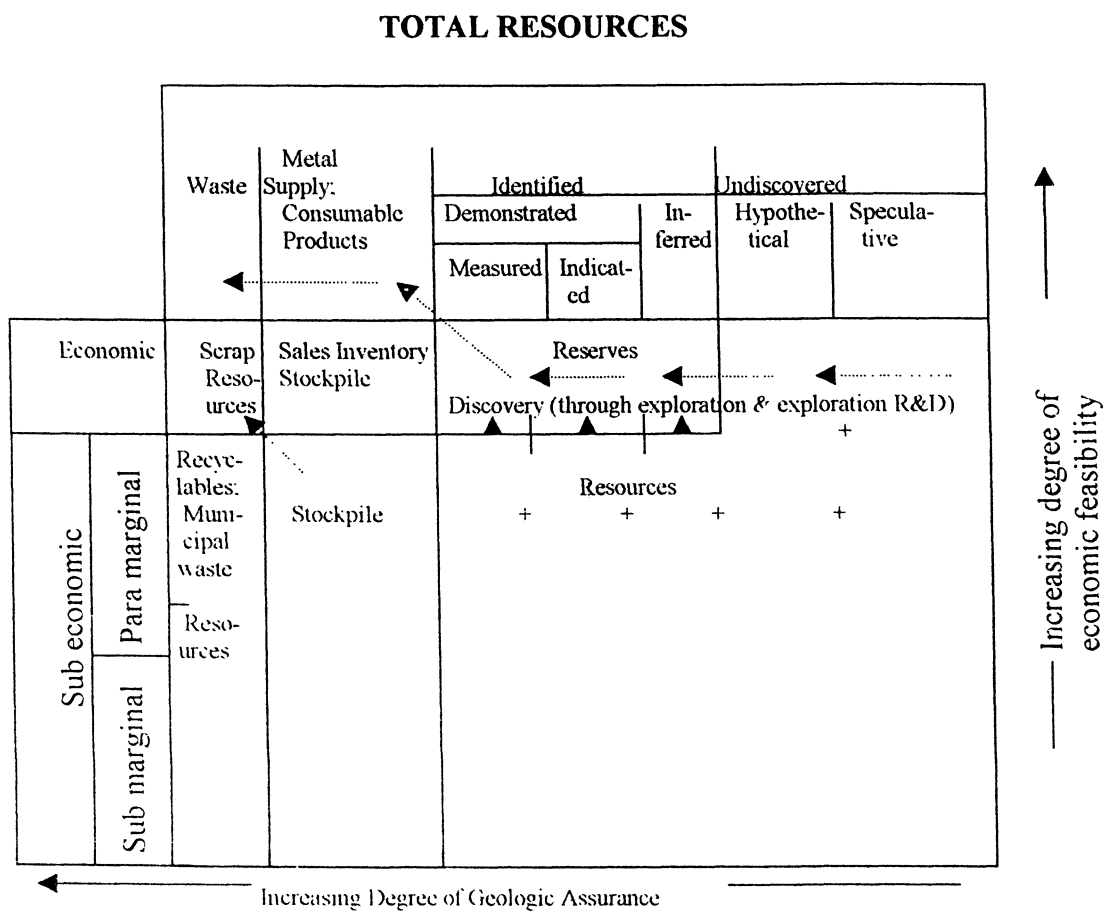


Fig.3: The Expanded McKelvey's Box. In this case, wastes and recyclables enter as a resource

To emphasize the role of feasibility of economic recovery, the vertical right-hand axis of this diagram indicates the increasing degree of feasibility going upward. The horizontal axis, moving from right to left, shows increasing degree of geological certainty

The obvious advantage of this box-method is that the classification of resources is more detailed and accurate or refined. It is being used in a number of Reserve estimates in the USA However, it is difficult to quantity both the right-hand vertical axis (indicating feasibility of economic recovery) and the horizontal axis (showing geological certainty) It provides consistent terminology and a common basis for comparison among minerals and fuels It also enables the analysis of the same mineral over different periods of time

The amount of past cumulative production is not, by definition, a part of the resource. Nevertheless, knowledge of what has been extracted till date is important to an understanding of current resources or the amount of remaining in-place resource. This net resource is of significance in policy related matters.

Some modifications are made to the above classification. For instance, the extent of the para-marginal reserves has been expanded to include UNPRODUCIBLE reserves because of legal and environmental restrictions. For instance, the coal reserves under townships say Dhanbad, railway lines, water bodies etc., belong to this category of unproducible reserves. Some renaming of terms also took place in recent years.

RESOURCES PLANNING:

Long term public and commercial planning must be based upon the following factors:

(1) The PROBABILITY of discovering new deposits.
(2) Development (likely) of economic extraction processes for currently unworkable deposits.
(3) Knowledge of "***which resources***" are immediately available for exploitation.

Thus, the resources must be continuously ***reassessed*** in the light of:

(a) New geological knowledge through exploration.
(b) Progress in science and technology; and
(c) Shifts in economic, social and political conditions.

To best serve the planning needs, the known resources should be classified from two standpoints:

(i) Purely geologic or physical/chemical composition--such as, grade, quality, tonnage, thickness, and depth-of the material in place; mineability; and
(ii) Profitability analyses based on costs of extraction and marketing the material in a given economy at a given time.

The resources planning is an integral part of the over all developmental planning in any given socioeconomic system. As a matter of fact, it is the precondition/pre-requisite for the developmental planning. Its role will be more pronounced if one adopts the theory of "**Planning from Below**". Planning means the planning for resources generation and utilisation. The resources as viewed and considered above form part of the developmental processes. Behind resources analysis, lies exploration.

RESERVES/RESOURCES : DEFINITIONS (as given by the US dept. of mines):

A dictionary definition of a resource, ***"Something in reserve or ready if needed"***, has been adapted for mineral and ENERGY resources to comprise all materials, including those only surmised to exist, that have present or anticipated future value. Thus, this definition is broad enough to encompass both the existing as well as the potentially available useful resources. Implicitly, this assumes the likely and possible changes in technology, markets, relative prices etc., that may convert the resources into reserves. This being the case, the economic analysis becomes a crucial and critical activity in resource analysis. In fact, this makes or unmakes a resource with utility and salability -- the two primary elements in a resource. For the sake of clarity and understanding, the following brief explanation of the general terms used in the analysis, evaluation and assessment of resources is presented.

RESOURCE: A concentration of naturally occurring solid, liquid, or gaseous material in or on the Earth's crust in such form and amount that economic extraction of a commodity from the concentration is currently or potentially feasible.

ORIGINAL RESOURCE: The amount of resource before production/extraction.

IDENTIFIED RESOURCE: Resources whose location, grade, quality, and quantity are known or estimated from specific geologic evidence. Identified resources include economic, marginally economic, and sub-economic components. To reflect varying degrees of geologic certainty, these economic divisions can further be subdivided into measured, indicated, and inferred.

DEMONSTRATED: A term for the sum of measured plus indicated. See below

MEASURED: Quantity is computed from dimensions revealed in OUTCROPS, trenches, workings, or drill holes; while grade/quality are computed from the results of detailed sampling. The sites for inspection, sampling, and measurement are spaced so closely and the geologic character is so well defined that size, shape, depth, and mineral content of the resource are well established. The degree of certainty is very high. They are available for immediate extraction. Hence, they can also be called as the WORKABLE RESERVES.

INDICATED: Quantity and grade/quality are computed from information similar to that used for measured resources; but the SITES for inspection, sampling and measurement are FARTHER APART or are otherwise LESS adequately SPACED. The degree of assurance, although LOWER than that for measured resources, is high enough to assume CONTINUITY between points of observation. In this case, the degree of certainty is low and hence calls for further exploration. However, the potential feasibility is high.

INFERRED: In this case, the estimates are based on an ASSUMED CONTINUITY beyond measured/indicated resources for which there are geologic evidence. Inferred resources may not be supported by samples or measurements. In this case, the degree of certainty is very low. They are not available for immediate exploitation. However, the inferences suggest the specific areas/sites for undertaking further exploration.

RESERVE-BASE: That part of an identified resource that meets specified minimum physical and chemical criteria related to current mining and production practices, including those for grade, quality, thickness, and depth. The reserve-base is the in-place demonstrated (measured plus indicated) resource from which reserves are estimated. It may encompass those parts of the resources that have a REASONABLE POTENTIAL for becoming economically available within planning horizons that assume proven technology and current economics. This is the most important of all the resource categories that are identified. They are crucial for decision/policy making with respect mainly to the developmental strategy including the international trade issues in minerals.

The reserve-base includes those resources that are currently economic (reserves), marginally economic (marginal reserves), and some of those that are currently sub-economic (sub-economic resources). The term "***geologic reserve***" has been applied by others generally to the Reserve-base category, but it may also include the inferred-reserve base category. This is not included in this classification system.

INFERRED RESERVE BASE: The in-place part of an identified resource from the inferred reserves are estimated. Quantitative estimates are based largely on the knowledge of the geologic character of a deposit and for which there may be NO samples or measurements. The estimates are based on an ASSUMED CONTINUITY beyond the reserve base for which there is geologic evidence.

RESERVES: That part of the reserve bases which could be economically extracted or produced at the time of determination. The term reserves NEED NOT SIGNIFY that extraction facilities are in place and operative. Reserves include only recoverable materials. Thus, the terms such as "extractable reserves" and "recoverable reserves" are redundant and are not part of this US classification system.

MARGINAL RESERVES: That part of the reserve bases which, at the time of determination, BORDERS on being economically producible. Its essential characteristic is ECONOMIC UNCERTAINTY. The resources that would be producible given the postulated changes in economic or technological factors, are included under this category. The market and the price are the two major parameters in this categorisation.

ECONOMIC: This term implies that profitable extraction or production under defined investment assumptions has been established, analytically demonstrated, or assumed with reasonable certainty

SUB-ECONOMIC RESOURCES: That part of identified resources that do not meet the economic criteria of reserves and marginal reserves. If price goes up or costs come down due to technology development, they become economical.

UNDISCOVERED RESOURCES: They are the resources the existence of which is only postulated, comprising deposits that are separate from identified resources. Undiscovered resources may be postulated in deposits of such grade and physical location as to render them economic, marginally economic, or sub economic. They are postulated mostly on the basis of surface data including the outcrops and other known or well-established correlations. To reflect varying degrees of **geologic certainty**, the undiscovered resources may be divides into two parts.

(a) **HYPOTHETICAL RESOURCES**:
Undiscovered resources that are similar to known mineral bodies and that may be reasonably expected to exist in the same producing district or region under analogous geologic conditions. If exploration confirms their existence and reveals enough information about their quantity, grade and quality, they will be classified as identified resources. In this case, the analogies play a significant role along with the surface data.

(b) **SPECULATIVE RESOURCES:**
Undiscovered resources that may occur either in known types of deposits in favourable geologic settings where mineral discoveries have not been made, or in types of deposits as yet unrecognised for their economic potential. If exploration confirms their existence and reveals enough information about their quantity, grade and quality, they will be reclassified as identified resources. The difference between this type and the earlier one is that the former refers normally to the mineral-bearing areas where extraction is already undertaken or likely to be taken up. On the other hand, the speculative type refers to the unknown areas where the geologic knowledge about the deposits is conspicuously non-existent. In this case, risk and uncertainty are very high when compared with the earlier type.

RESTRICTED RESOURCES/RESERVES: The part of any resource/reserve category that is restricted from extraction by laws or regulations. They meet all the requirements of reserves except they are restricted from extraction by laws or regulations. For instance, the coal reserves under the townships, railway lines, water bodies or under valuable properties like buildings etc., or the coals with higher sulfur content as in the U.S., belong to this category.

In the context of public policy and natural resources, this section on resource-base analysis in its entirety helps to discover, estimate, evaluate and assess the strengths and weaknesses of the economic system with respect to the known and potential or suspected natural resource endowments. Further, it also gives broad guidelines for the development of resource-specific appropriate technology to harvest the known resource base. On the whole, it helps to improve our understanding of the implications of resource base and consequently, the policy design.

CONCLUDING OBSERVATIONS:

It may be noted that different countries adopt different classificatory systems in resource appraisals. For instance, the terms "proved", "probable" and "possible" which are commonly used by industry in economic evaluations of ore or mineral fuels in specific deposits or districts have been loosely INTERCHANGED with the terms measured, indicated and inferred respectively.

Classification is the first and the most crucial step in analysis whether it is for policy or for research. It reveals a number of interesting things like patterns, sequences and mutual correlations among the units categorised. Whichever type of categorisation is adopted, the purpose is the same. Its primary aim is to assess the present and the future availability of resources at varying degrees of market conditions, technology and relative price levels. On the basis of these appraisals, various policy options can be worked out with respect to trade exploitation, conservation and so on.

However, it is interesting to note that the resources are arranged in a probability-framework, or in other words, in the ascending order of probability. In this context, probability refers to the extent of certainty with which a resource can be converted into a reserve and thereafter to a workable/extractable reserve. It also shows the extent of certainty in making available the required resources for developmental purposes both for the present and the future. The probability matrix can be considered to serve both as an analytical tool and a policy instrument as well.

Now, there is a need to have a fairly uniform classificatory systems to make meaningful comparisons between/among countries and to have a clearer understanding of the resource base for various developmental plans, policy measures and investment programmes of the Energy and Non-energy Companies.

This is how, all the natural resources, both fuel and non-fuel mineral resources are classified. Categorisation under various headings will be of immense use both in planning and policy-making for the socio-economic development of a particular country without which the planning perspectives or goals remain merely as political slogans Further, it is also necessary in the dynamics of resource analysis as to how the shifts in resource assessments/updates takes place and how the resources get changed from one category to another depending upon the technology of exploration and the state of markets.

Science and Technology assigns utility to resources while markets attach value/price These are the two major determinants in resource evaluation. This being the case, the guidelines for the development of S & T with respect to the exploitation and utilisation of mineral resources need to take into account explicitly the resource-base analysis as explained here. In other words, an appropriate technology has to be developed depending upon the extent and quality of natural endowments. The mismatch between the two needs to be avoided with the help of resources analysis. This is its applied usage.

It may be noted that the basis for the above explained classificatory systems is essentially the EXTENT and the degree of INTENSITY of exploration undertaken in a particular region combined with the techniques of exploration. The output/outcome of exploration activity is not production but KNOWLEDGE about the resource--its likely quantity, quality, mineability, depth and so on. Depending upon the extent, reliability, and the degree of accuracy of this knowledge, the resources get classified accordingly under various headings as above. Thus, the extent of exploration is the basis for resource analysis and classification.

Since economic development, as said earlier, is nothing but the commoditification of resources in effect, the knowledge on the resources analysis and evaluation is a precondition to the developmental programmes which in turn are the outcomes of public policy. Thus, the scope of public **policy design** is enlarged to encompass the major elements such as technology, resources analysis and evaluation, markets, exploration and conservation.[8] The policy-design, therefore, needs to be reoriented to cover the supply-side management approach. What is needed is a paradigm shift in policy-making processes to make public policies more realistic, meaningful and fruitful.

For the sake of brevity, the interface between the resoruce-base at one end of the spectrum and public policy at the other, is presented in chart-2 on the next page. Since our interest is focussed on the resource-base, the public policies are narrowed down to only three components at the exclusion of other components like the defence, law and order, foreign relations etc. The Chart-2 is self-explanatory because the material for making this chart is drawn from the text. However, it can only be reiterated that this chart presents the broad elements of the new paradigm and their inter-connection.

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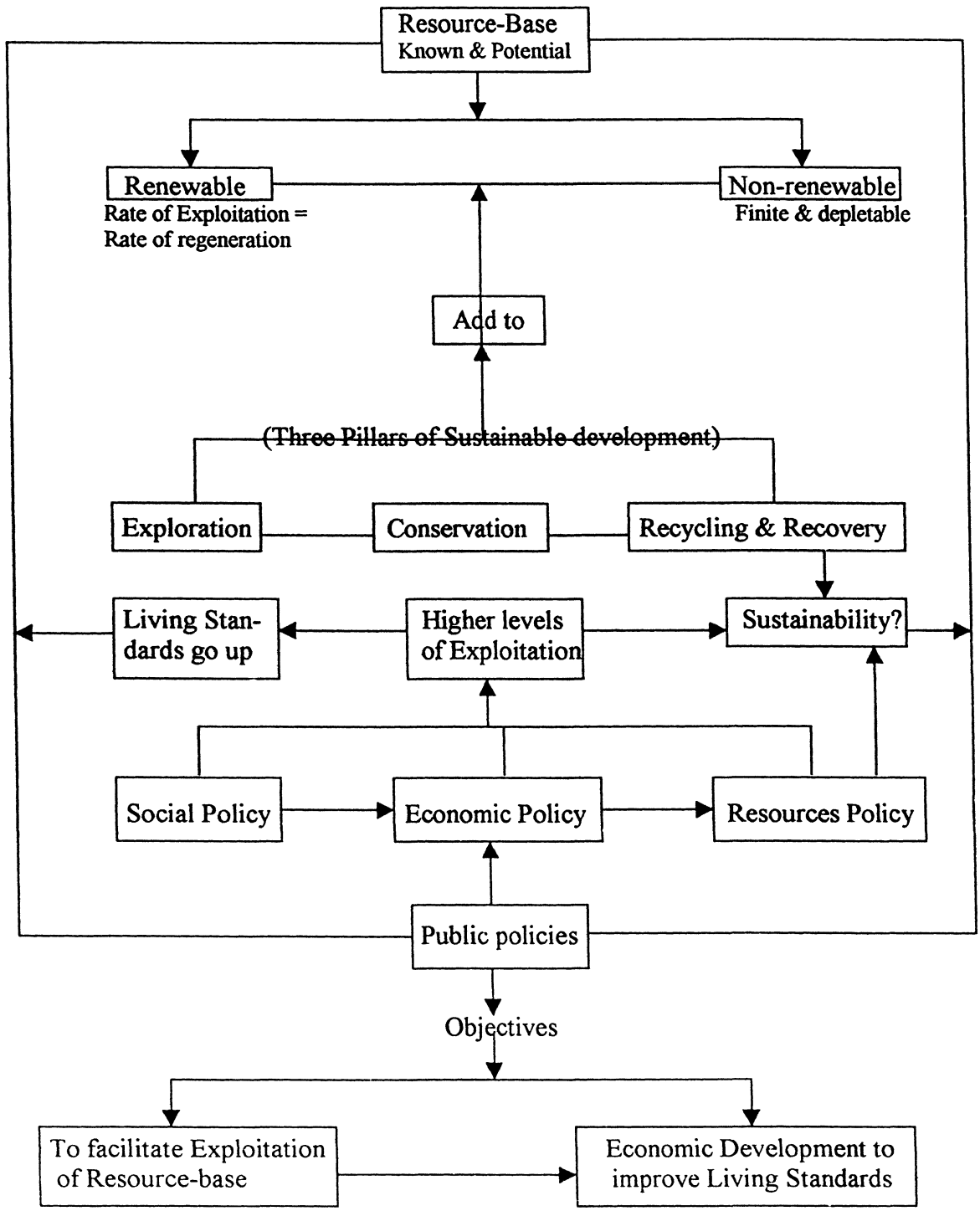
[8] Werner R Gocht, Half Zantop and Roderick Eggert. **"International Mineral Economics"**, Spinger-Verlag, New York, 1988.

This is an extremely useful book in the context of "public policy and natural resources" as also in devising an appropriate **policy-design** to make public policies under new conditions of supply side-management in place of the present practices of demand-side management. But it needs a lot of effort in integrating public policy making with exploration, conservation and other elements of supply-side management approach.

Chart-2

CHART SHOWING INTERFACE BETWEEN RESOURCE-BASE AND PUBLIC POLICY



PART – III

Empirical Assessment of Resource-base
- Some Illustrations

Empirical Assessment of resource-base
- Some Illustrations

We have explained earlier in Part-II the meaning, scope and the dynamic nature of the resource-base. Among other things, it has been observed that the two properties viz.,

- Salability, and
- Utility

will make or unmake a resource, or convert a neutral stuff into a resource. It is the technology that convert a neutral stuff into a resource and a resource back into a neutral stuff. In the context of resource analysis, it may be noted that technology acts in different ways as below:

a. Increase the level of recovery in extraction of a given deposit as also reduce the mining costs through mechanisation.

b. Helps increase the recovery rate from ores through better smelting etc.

c. Reduce the energy and material intensities in products or enhance the life spans of mineral deposits by dematerialisation of products.

d. Development of substitutes to overcome scarcities in materials supplies and thereby, make or unmake markets for minerals.

e. Recycling and Recovery from wastes/scrap/residuals which has a bearing on resource-base. Enhances supply-potential for future.

f. Achieve both exploration and conservation of mineral resources and thereby, increase the life spans of deposits.

g. Gives "salability and utility" to the neutral stuff to become a resource and thereby, create markets for the mineral resources.

h. Brings new uses to the supposedly useless stuff such as the mineral-wastes at the mine sites.

i. Combats the `niggardliness of nature' expressed in terms of quality variations and other geo-mineralogical properties.

Thus, technology plays a vital role in creating and destroying markets for the mineral resources, and in determining the extent of resource-base/supply potential and its longevity. Technology and resource analysis are thus intertwined together (See, Chart-3 in Naganna,2000). One can not exist without the other. Technology came into being due to resources and vice versa However, all technological developments come to us with a

price tag. This is what history unfolds. But, the pre-condition for technology and development is the stock of natural endowments or the resource base. The later determines the extent of supply potential to the economic system as also its carrying capacity and the extent of sustainability.

In this section, an attempt is made to explain the dynamic nature of resources through some illustrations to exhibit how neutral stuff gets converted into a resource and how a resource is converted back into a neutral stuff. In this context, a resource is considered as a material with "salability and utility" which is "technically & commercially" recoverable from the earth's crust. On the other hand, a neutral stuff does not satisfy these parameters. It is neutral to "utility and salability" and it is just a naturally occurring substance on or below the earth's crust.[1] Both "technically & commercially" recoverability is the main distinguishing feature of a resource.[2]

In what follows is a situational analysis with a brief explanation of changes in resource base due to changes in technology and markets. The subject matter on hand is illustrated through a few cases, each representing a particular situation on resource analysis and evaluation. The selection of the cases is partly random and partly the familiarity of the author with these cases.

1. The Case of Mica: exhibits an interesting phenomenon. Mica is a vein type of mineral blended with pegmatite hard rock. Originally, it was just a neutral stuff existed since times immemorial. Some time back, S & T was developed to use mica for industrial uses in electrical and other industries. Thus, markets grew for mica and in turn, it became a resource from a neutral staff. Because of its richness in mica endowment, India soon became one of the major producers and exporters of mica in the world. One time, it occupied more than half of India's mineral exports in value terms. Its supremacy continued for a few decades. However, the scenario changed drastically in recent years. Significant technological changes took place and a number of substitutes were developed to replace the expensive mica in its industrial uses. Consequently, it started loosing its markets gradually in recent years. Because of these developments, mica is slowly tending back towards the status of a neutral stuff from a resource.

The empirical evidence as given in Table-5 confirms the fact that mica is slowly tending back towards a neutral stuff. The number of mines, quantity produced and the labour employed in mica mines in India declined substantially in 1995-96 over the year 1986. The closure of mica mines and the labour displacement are causing a number of social problems both in Bihar and Andhrapradesh. Whatever it is, the resource-base of mica remains in tact and undiminished for the use of future generations. Technology may revive its supremacy.

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[1] It is also recognised that there is an another kind of flow. It is from neutral stuff to resources to reserves. In this case, the 'resource' refers to all geological occurrences of a mineral scattered over large tracts of land while the 'reserve' refers only to the 'technically & economically' recoverable resources. This is not adopted in the present illustrations.

[2] Environmental impact analysis (EIA) of mining and beneficiation is deliberately avoided in this context.

2. The Case of Barytes: It is a vein type of mineral used in barium chemicals, rubber, paints, paper and other industries. It is a dense material. Like mica, it was also a neutral stuff in the beginning. Later with technological developments and industrialisation, it was converted into a resource with ever expanding markets. Still, it continues to be a valuable resource to the economy. But it presents a different situation/picture. By its quality, it is categorised into A, B and C grades. The poor quality C grade barytes did not have markets for long and hence, it was thrown into the open lands at the mine sites, causing severe environmental damages. Whatever it is, C grade barytes was a neutral stuff while A and B grades were a resource. Therefore, this exhibits the fact that the statuses of both "neutral stuff" and 'resource' can exist for the same mineral at the same time. In other words, a mineral can be both a "neutral stuff" and a "resource" at the same time.[3] The cognizance of this fact will improve the quality and reliability for the resource analysis, assessment and evaluation in material surveys.

The story of barytes does not end here. In recent years, a lot of technological developments took place in the field of oil-drilling and oil exploration which found a new use for the low grade (C) barytes. Consequently, the poor quality C grade barytes which was discarded as useless stuff at the mine sites, found growing markets. Thus, the one-time neutral stuff (C-grade barytes) became a valuable resource due to technology and markets. Therefore, technology and markets play a crucial role in resources analysis and materials surveys.

[3] It may be noted that all the grades of different qualities are mixed up below the earth's crust. In digging for the mineral, one gets all grades mixed up and this calls for a "benefication" process to sort out the grades and remove impurities

Table 5

PRODUCTION OF MICA (CRUDE) (1986 – 95-96)

Year	Quantity (000 tones)	Value (Rs. Crores)	No. of Mines	Labour Employed (Av. Daily)
1986	4.7	2.9	165	3345
1987	4.3	2.7	181	3316
88-89	3.9	2.9	148	3105
89-90	4.1	3.1	145	3354
90-91	4.1	3.2	137	2942
91-92	3.6	3.0	134	2840
92-93	2.6	2.4	127	2385
93-94	2.1	2.3	112	1974
94-95	2.0	2.6	95	1690
95-96	1.8	2.2	76	1402

Source: **"Indian Mineral Industry"**: At a glance : 1995-96. IBM, Nagpur

Major consumers of Mica: Electrodes & Electrical Roofing Materials, Electrical Machinery, Mica Paper, Oil Well Drilling, Paint, Plastic, Rubber Tyres, Refractory etc.

3. The Case of Limestone: It is a stratified mineral used in cement and chemical industries. It is available in abundant quantities. By its quality, it can be broadly divided into two types viz., cement-making (low quality) and chemical-making (high quality). It was reported to me during my field visits to some of the mineral-bearing areas that the farmers were using unknowingly the high quality (chemical) limestone for constructing the fencing walls to their farms, thinking that it does not have value (or a neutral stuff). Later, technology and markets were developed and expanded for the high-grade limestone. Now, the same farmers remove the high grade limestone from their fencing walls and load into the trucks to sell it to the chemical industry. In this case, the people's **perception** and **information** about the markets enter into resource analysis and evaluation. In a sense, neutral stuff became a resource through a different route.

4. The Case of Coal: It presents an altogether different situation/picture which shows that both the statuses of a "neutral stuff" and a "resource' can exist at the same time for the same mineral in the same mine. Incidentally, this presents a challenging situation to the conservational policies and practices.

Needless to say the role and significance of coal to the economy. Barring the outcrops, the coals are embedded at different depths far below the earth's crust in the form of beds, called the seams. In a coal mine, there can be more than one coal seam depending upon the bounty of natural endowment. For instance, say, there are four seams in a coal mine – the top two and the bottom two. In this case, the top two seams are "technically and commercially" workable and hence, they are considered to be a "resource". Whereas, the bottom two seams are not "technically and commercially" recoverable and hence, they are to be treated as a neutral stuff. Because, it is difficult to extract the bottom most seams due either (a) to prohibitively high mining costs or (b) technologically may not be feasible, or even both. Thus, this case presents a situation wherein a mineral can have both the statuses of a "neutral-stuff" and a "resource" simultaneously in the same mine. In other words, half of a mineral deposit can be a neutral stuff while the other half can be a resource in the same mine. This is true not only in the case of coal but also true for many a mineral. And, this is an end for the beginning of a new insight into the resource analysis and evaluation.

It is normally found that the bottom seams will be of high quality and hence, a more valuable asset than the top seams. If they are left un-mined due to higher costs, they will then become a permanent loss to the present and future generations because reopening of a coal mine when once closed becomes almost impossible. Thus, achieving conservation becomes highly critical and subsequently, sustainability. Because the market/price/mining costs allow the extraction of only the top two seams while the bottom two are left untouched. This kind of damaging/wasting the resource is called, in mining parlance, as the skimming of deposits or the slaughter mining practices which picks up the best to maximise the profits. This kind of skimming the deposits needs to be checked through the conservational practices and public policy measures.

Thus, high quality coal seams are locked up in bottom seams and they are not available either for the present or the future. The valuable resources are thus damaged/wasted due to improper management practices. This the conservation principle attacks. It is an issue for public policy to see that the precious resources must not be wasted/damaged as above. As a matter of fact, those two bottom seams can be extracted, if technically feasible, either through cross-subsidization or through economic incentives like subsidies, tax concessions etc., or with any appropriate policy instrument. The whole concern of conservation principle is to see that no mineral is damaged/wasted during the extraction process. Still, there is a long way to go in achieving conservation of resources.

In the same vein, one of the authors brings out a highly educative case where an **ore turns out into a rock** or in other words, from a resource to a neutral stuff because of **taxation policy** which affects the big and small mining companies in different ways. He says that "a deposit is nothing but rock to one company, yet is an economic ore body to another company" [4] In other words, the same mineral can be a neutral stuff to one

[4] Robert B Parsons, "Turning Ore into rock", (pp. 239-242) in FJ Anderson (Ed), **"Selected Readings in Mineral Economics"**, Pergamon Press, 1987. The very title of the paper itself viz., "Turning Ore into 'Rock" speaks a lot as also confirms the role played various policy instruments such as taxation, direct controls, economic incentives etc , in resource analysis and conservation

mining company while it is a resource to the other because of differential tax burdens. This case presents a different scenario/situation in which the taxation policy enters explicitly into the resources analysis and evaluation. It also reveals the fact that the durability/life spans of the mineral deposits or the resource-base is amenable to manipulation through appropriate policy instruments. Accordingly, the analysis as presented in this Case No.4, exhibits an imperative need for state intervention/public policy to achieve conservation by mitigating the slaughter/selective mining practices.

5. The Case of Iron Ore Mining: India is indeed rich in iron ore endowment both in terms of quality and quantity. Since it is plentiful, the country entered into the commodity agreements to export iron ore to other countries to earn foreign exchange. According to the agreements, the country has to export iron ore with 55-60% ferrous content (high quality). In fact, technology has been developed in some countries to use iron ore with even 45% ferrous content[5] (low quality). The Indian iron one exports present a clear case of **skimming** the deposits under desperate conditions. This is in fact disastrous to conservation of resources because the lesser grades are damaged at the mine sites. Further, this iron ore case reveals the fact that a mineral deposit may be a neutral stuff in country while the same can be a resource in another country depending upon the technology.

In India, ore dust coming out of extraction process is not used at all and is thrown into open lands at the mine sites causing environmental damages. The same is a punishable crime in other countries. Therefore, a neutral stuff in one country is a resource in others.

The case of iron ore brings out the issue of international dimensions into resources analysis. It also highlights the need for stringent conservational measures to mitigate the skimming of deposits or the slaughter mining practices.

A Synoptic View of Resource-base:

The above five cases present five different perspectives on resource analysis and valuation. In fact, they throw more light on the conceptual analysis of resource base as presented in Part-II of this working paper by giving briefly five different kinds of situational analyses. All the five cases confirm the fact that the resource base is not a static concept but inherently dynamic and it varies with technology, markets and conservational policies.

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[5] As a matter of fact, it has been reported that even 30% Fe content in iron ore is profitable for extraction. See, A.M. Hussain, **"The Economics and Economic Geology of the Mineral Industries"**, p 35, Allied Publishers, New Delhi, 1985.

But the exploitation of low grade/quality ore **conflict** with the environmental management because the removal of overburden and other mineral wastes is much larger than otherwise. Thus, conservation and environment conflict with each other on several counts in the mining sector. A similar is the case with the choice of mining systems. A number of trade offs need to be made in resource policy keeping in view of the relative scarcities and the state of prevailing environmental quality.

Whatever be the contribution of technology to mankind, the undisputable fact is that the resource-base is finite, exhaustible and non-replenishable. While solving a problem, technology may create either a new problem or add a new dimension to the problem on hand; or even the solution itself may become, at times, a problem. Technology, therefore, has its own price tag.

We should not take a license from the future technology to rationalise and justify our current lavish, reckless and wasteful consumption patterns which are based on the wishful assumption of unlimited supplies of materials and at low prices[6]. Due to this assumption, there is a rampant **over-specification** of products resulting in over-exploitation of resources. This needs to be checked in the interests of sustainability.

The present and the unborn succeeding generations have an equal right and equal access over the resources. By our slaughter mining practices and over-exploitation of resources, it is **unfair** to imperil the welfare of future generations merely because they are unrepresented in any political or economic forums. The finiteness of our resource-base calls for an immediate action to see that the posterity will inherit as much natural wealth as we have inherited from our predecessors. This is an ethical question which calls for stringent conservational policies. One has to see the several kinds of avoidable wastes that take place at the mine sites, to believe. Plundering of the mining sector in the name of development should be curbed.

The empirical evidence as given in the above five cases on the mining sector shows that there is an imperative need for state intervention to implement the stringent conservational measures to see that the future availabilities/supplies of materials do not dwindle in any significant measure and thereby, see that sustainability is achieved both in letter and spirit. Further, the five cases bring out the complexities and difficulties involved in the assessment of the inherently dynamic resource base or the extent of future supplies of resources. They pose a number of estimational problems.

Technology should not only be developed to exploit and use the resources but also to save resources for future. It needs to be considered not only as a cost-saving device but mainly as an instrument to achieve sustainable development.

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[6] It has been empirically observed that the natural (particularly, mineral) resources are **under-priced** due to the exclusion of social and other environmentla/reclamation costs. They are passed on to posterity. Therefore, their pricing do not reflect their real scarcity value or all the costs involved. The under-pricing like the subsidies lead to the over-use of scarce resoruces as also encoruage the avoidable wastages or the wasteful and reckless consumption patterns in society.

MINERALS POLICY – **as a pre-requisite to public policy:**

The nature and significance of mining sector in the general run of the economy as explained earlier demands that the minerals policy is to be considered as a **precondition** for the formulation of general public policies. Because the former lays the foundation for the later. To make it wider, the minerals policy may be enlarged to cover all the natural resources, i.e., both renewable and non-renewable resources, though our concern here is limited to only minerals. The following **three major issues** have been identified in the formulation of a national minerals policy, viz., (a) the issue of smelting and processing, also benefication, (b) the issue of scarcity, and (c) the issue of security. These three issues will have to find their due space in the national minerals policy.

The very definition of mining as the '**destructive use of land**' requires that the minerals policy needs to be integrated with the environmental policy, particularly the forest policy. Another distinguishing trait of the mining sector is its depletability/non-replenishability and consequently, it has to constantly cope with the ever depleting base while at the same time meeting its production targets to meet the requirements of the other sectors of the economy. This is its peculiar feature. A realistic minerals policy must take the following basic geological considerations in to account:

a. The currently accessible minerals in the earth's crust is limited,
b. They are non-renewable, and
c. The regional distribution of the known mineral deposits is highly uneven.

Keeping all this in view, the minerals policy has to encompass the following broad elements.

a. Exploration to replenish the depleted stocks.
b. Conservation to maximise the levels of recovery from the working deposits; to reduce all kinds of wastes during mining; to curb the slaughter mining practices or skimming of deposits.
c. Take into account explicitly the environmental dimensions through EIA including the plans for land use and reclamation.
d. Recover, reuse or recycle the mineral wastes/residuals/scrap coming out of both mining and benefication to gain the double advantage of achieving conservation and protecting or even improving the environmental quality.
e. Ensure maximum recovery from smelting and processing.
f. Substitution of scarce by abundant resources. Substitutes to replace scarce resources.
g. Reduce energy intensities and Input-output ratios or dematerialisation of products to reduce the pressure on mining sector and to attain sustainability.
h. Apply full-cost pricing reflecting scarcity value, social costs etc., to avoid over use of materials and wasteful consumption. Curb under-pricing of resources to change the consumption habits/patterns in society.

To support and complement these elements, other items such as: long term demand forecasting, detailed inventory of all minerals, market studies etc., may be added.

There is still one more problem with the minerals. They vary widely in terms of their quality, mineability, costs and benefits, their value and significance, their environmental impacts/social costs, risk and uncertainties and so on by their types such as: vein or stratified; metallic or non-metallic; major or minor; strategic or non-strategic. By their very nature, they are highly heterogeneous with respect to their geology, chemical composition, economics, mineability, utilisation, environment and contribution to GDP. Therefore, it is difficult to formulate a uniform policy for the whole mining sector. A segmented approach is necessary to the over all national minerals policy.

Mineral resources being what they are, the minerals policy has to be integrated and synchronised with the over all developmental strategies to ensure sustainable development. In other words, it is suggested here to integrate the supply-side management approach with the existing systems of public policy making.

It is not difficult to formulate an academically sound minerals policy but the whole problem lies in implementation. Therefore, the concern is to be shifted to public administration to see that implementation is carried out both in letter and spirit to make the policies more effective and fruitful.

CONCLUSION

Public expenditures form a very high proportion of total expenditure in the economy. Plan documents, budgets of central, state and local self-governments, all together will give the nature, scope, magnitude and extent of public expenditures in the economy. The public expenditure programmes are the direct outcomes of public policies and they are an integral part of the implementation strategy. All the governments across all the countries in the world have generally accepted the fact that their major objective is to improve the living standards of their citizenry through generating more employment, achieving economic growth and increasing social welfare. To achieve these laudable social objectives, there are broadly two approaches available for the policy-makers to carry on the economic management at the national level. They are:

a. Demand-side management consisting mainly of budgets, taxes, fiscal and monetary policies, guided mostly by Keynesian economics, and

b. Supply-side management comprising the resource-base analysis, exploration, conservation, materials surveys etc.

It has been observed that the evaluation and assessment of material supply-potential does not enter in any significant measure in policy-making exercises. The present paper is directed towards this end. The paper argues that the present public policy making needs to be done under entirely new conditions keeping in view of the future materials availability/supply, environmental constraints, population explosion and sustainable development.

Development is mainly built upon a continually depleting resource-base because development means extraction and extraction means depletion. Resources are finite and non-replenishable. Therefore, the crux of the matter is that **growth contains decay** or decay is embedded in growth. The cognizance of this awesome reality compels the policy-making machinery to consider **sustainability as its core concern** instead of showing a peripheral concern as is the case now.

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